Layers, Blend Modes, Opacity & Masks in ImagesPlus

A layer is an image. If you have two layers L_1 and L_2 then it is natural to combine or blend the two layers in different ways to achieve different results. The combination function $C(L_1, L_2)$ between two layers consists of the three functions. A blend mode function BM(x, y) is applied first to mix L_1 and L_2 to create an intermediate image I_1. A mask function M(x, y) is used next to mask blend I_1 with L_1 and create a second intermediate image I_2. The opacity function O(x, y) is used last to mix I_2 with L_1 to create the final image. The combination function to blend layers L_1 and L_2 is the composition of BM, M, and O given by,

$$C(L_1, L_2) = O(L_1, M(L_1, BM(L_1, L_2)))\ ,$$

where $BM(L_1, L_2) = I_1$ and $M(L_1, I_1) = I_2$. Let's take a close look at each of the three combination functions.

Mask Function.

A mask is a gray scale image that defines a pixel by pixel blend of two layers. The pixel values m(x, y) of the gray scale mask image can range from black at 0.0 through medium gray at 32500.0 to white at 65535.0. The mask blend function M(x, y) associated with a gray scale mask is,

$$M(x, y) = (1.0 - (m(x, y) / 65535.0))\ L_1(x, y) + (m(x, y) / 65535.0)\ L_2(X, Y),$$

where $L_1(x, y)$ and $L_2(x, y)$ denote layer 1 and layer 2, respectively. The mask blend function M(x, y) is setup so that a darker mask pixel m(x, y) blends in more of layer 1 than layer 2 while lighter mask pixel values blend more of layer 2 than layer 1. So if a mask pixel is black then m(x, y) = 0.0 and layer 1 is used 100% while layer 2 is used at 0%. If a mask pixel is white then m(x, y) = 65535.0 and layer 1 is used at 0% while layer 2 is used at 100%. If a mask pixel is gray then a weighted average of the same pixel from layer 1 and layer 2 is performed. *In summary dark mask areas hide layer 2 and reveal layer 1 while lighter mask areas reveal layer 2 and hide layer 1 as shown in Figure 1.*

To use a mask the mask must be assigned to a layer (image) and is then it is called a layer mask.

Opacity Function.

The opacity function mixes 2 layers by mixing the same percentage of layer 1 with layer 2 at each pixel. Opacity *O* can range from 0.0 to 1.0 or transparent to opaque, respectively. The opacity blend function O(x, y) is given by,

$$O(x, y) = (1.0 - O)\ L_1(x, y) + O\ L_2(x, y).$$

The opacity function is very similar to the mask function. The difference between the mask and opacity function is simple. The opacity value O is constant at each pixel of the two layers so the opacity function performs the same weighted average at each pixel. Each pixel of a mask can have any value from black = 0.0 to white = 65535.0 so the weighted average performed by the mask function can be different at each pixel.

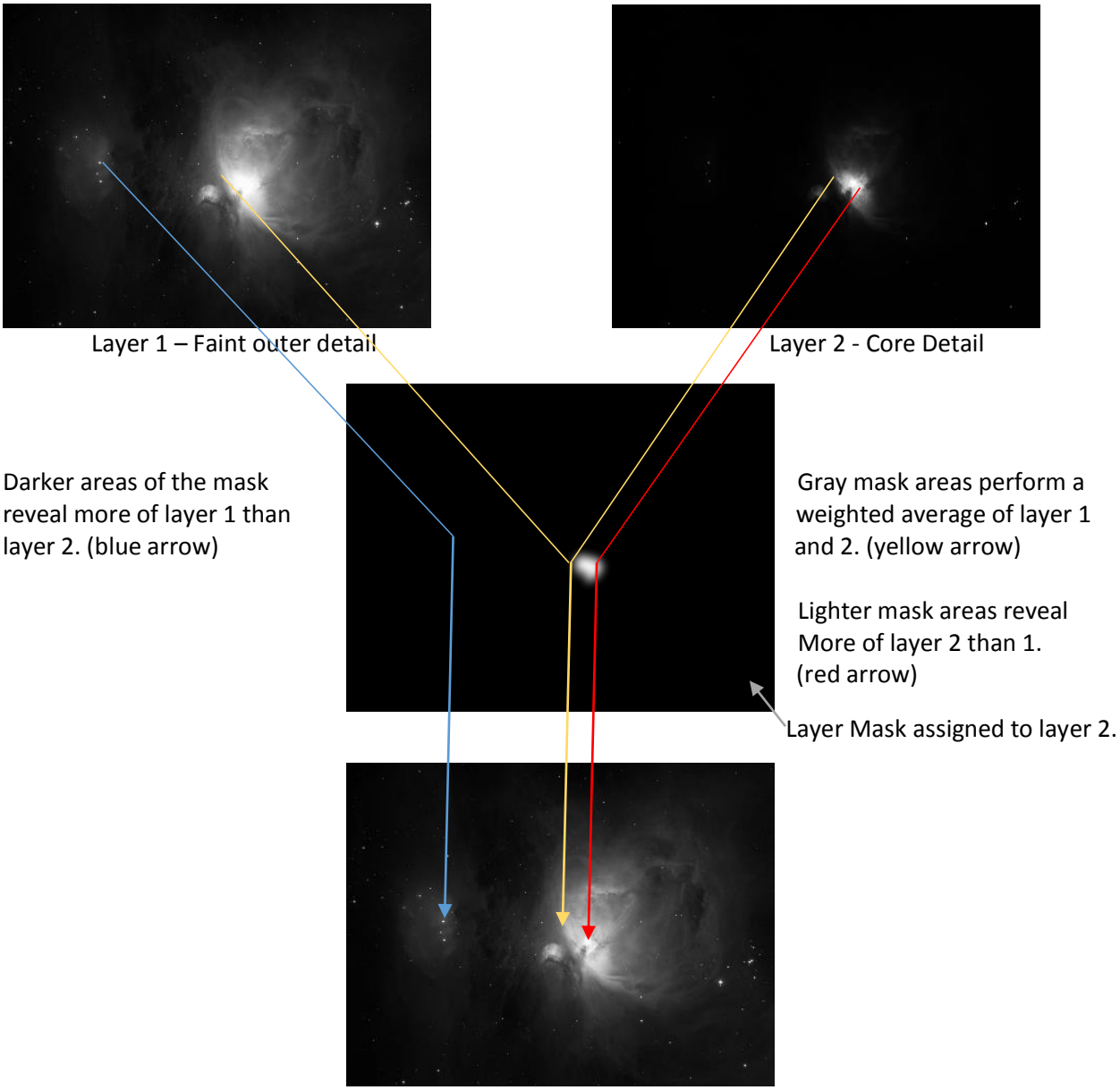


Figure 1 Final image created by the mask blend of layer 1 and 2.

Blend Mode Functions.

A blend mode is a function $BM(L_1, L_2) = L_3$ that defines a pixel by pixel map of two image layers L_1 and L_2 to create a third image layer L_3. The order of the input layers L_1 and L_2 is important since $BM(L_1, L_2) \neq BM(L_2, L_1)$ for all blend modes and this is why L_1 is referred to as the bottom or previous layer and L_2 the top or current layer. If $BM(L_1, L_2) = BM(L_2, L_1)$ then the blend mode is commutative and the layer order does not matter. For a color image blend modes are applied to the red, green, and blue channels independent of each other.

The blend mode function definitions below assume that black = 0.0, white = 1.0, and [0.0, 1.0] is the image pixel value range.

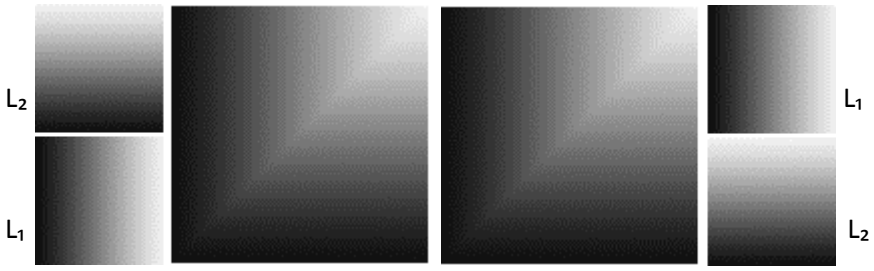
Normal The default blend mode where the current top layer L_2 hides the previous layer L_1 completely,

$$BM(L_1, L_2) = L_2.$$

Darken Blend Modes The next four blend mode functions all darken the previous or bottom layer L_1 using the current or top layer L_2.

Darken Selects the minimum or darkest of the two pixels.

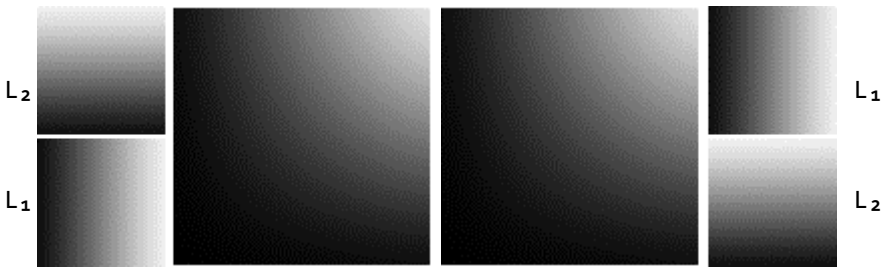
$$BM(L_1, L_2) = \min(L_1, L_2)$$



$$BM(L_1, L_2) = BM(L_2, L_1), \text{ commutative}$$

Multiply White is unchanged and no part of the image gets lighter. Darkens the previous image directly based on the darkness of the current image.

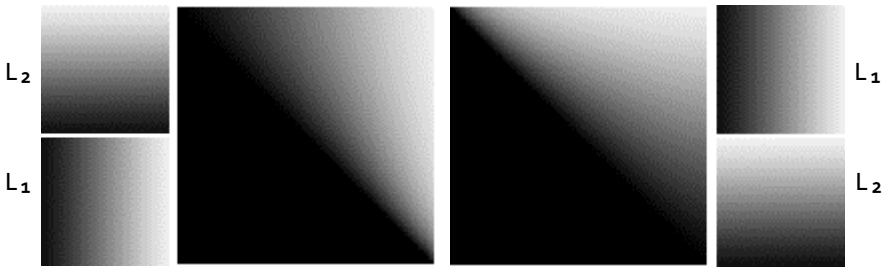
$$BM(L_1, L_2) = L_1L_2$$



$$BM(L_1, L_2) = BM(L_2, L_1), \text{ commutative}$$

Color Burn Burns in the color of the current image with the previous image. No part of the current image will get lighter.

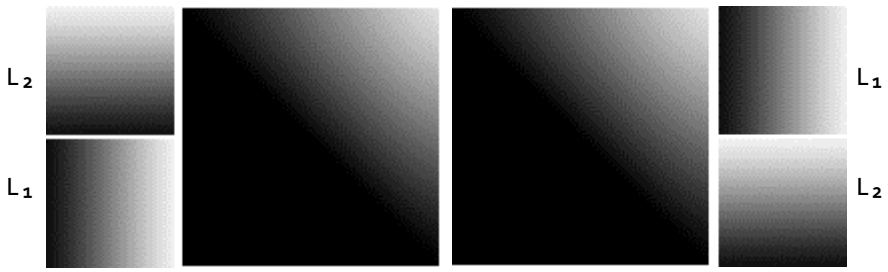
$$BM(L_1, L_2) = 1.0 - (1.0 - L_1)/L_2$$



$$BM(L_1, L_2) \neq BM(L_2, L_1), \text{ not commutative}$$

Linear Burn Similar to color burn but the results are more intense.

$$BM(L_1, L_2) = L_1 + L_2 - 1.0$$

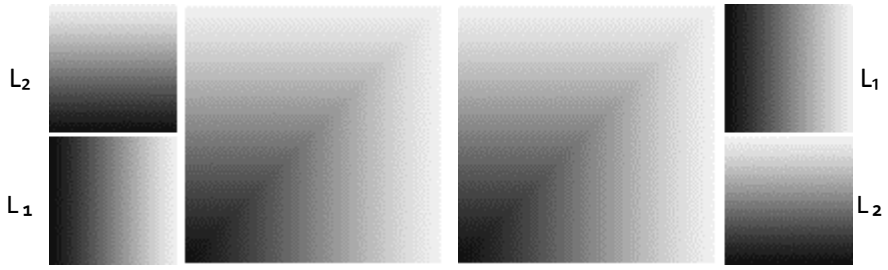


$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

Lighten Blend Modes The next four blend modes all lighten layer L_1 based on layer L_2.

Lighten Selects the maximum or lightest pixel from the current and previous image.

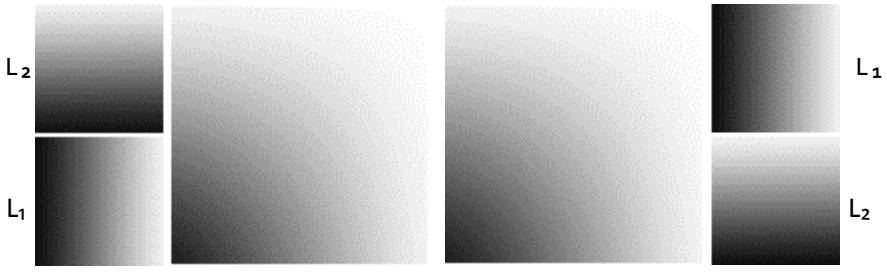
$$BM(L_1, L_2) = \min(L_1, L_2)$$



$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

Screen Brightens by lightning the previous image based on the lightness of the current image. The result is always lighter.

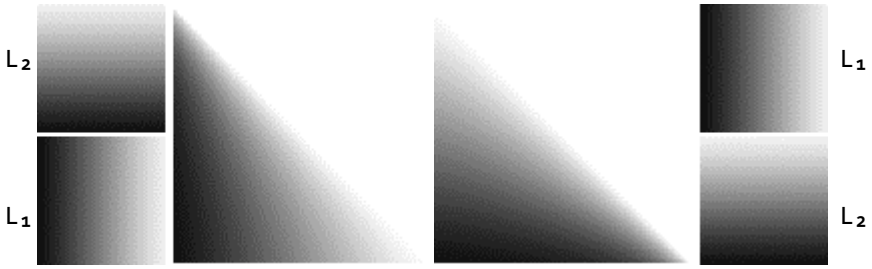
$$BM(L_1, L_2) = 1.0 – (1.0 - L_1)(1.0 - L_2)$$



$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

Color Dodge Similar to screen but with more intense results.

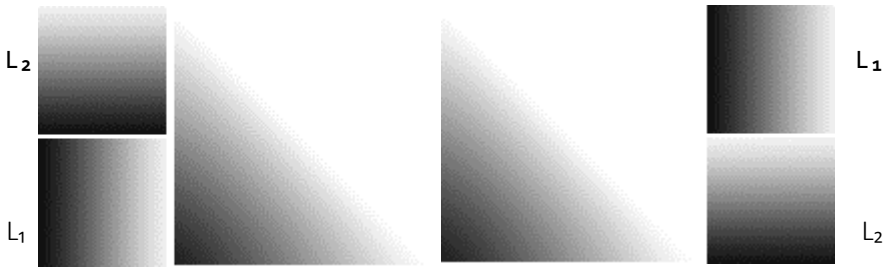
$$BM(L_1, L_2) = L_1 / (1.0 - L_2)$$



$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

Linear Dodge Similar to color dodge but with more intense results.

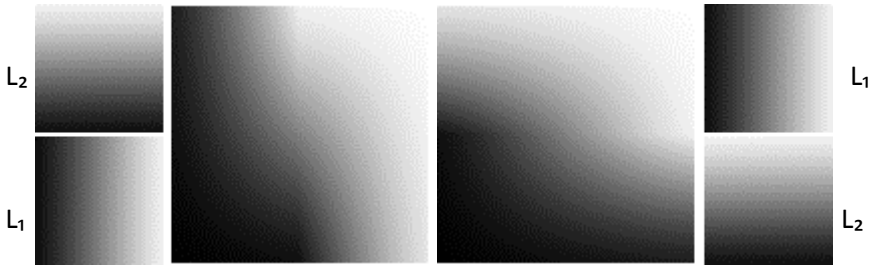
$$BM(L_1, L_2) = L_1 + L_2$$



$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

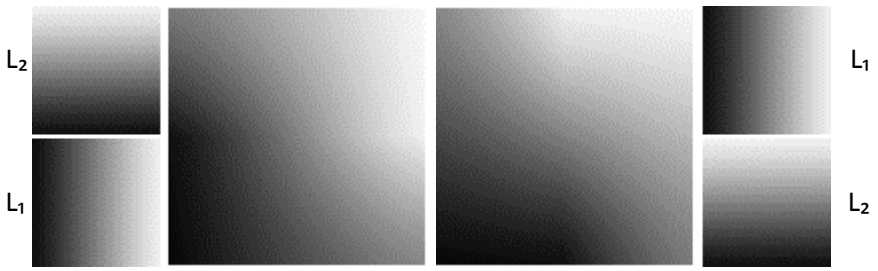
Contrast Blend Modes Contrast blend modes are a mix of multiply, screen, color dodge, color burn, linear dodge, and linear burn.

Overlay Multiplies light areas and screens dark areas. Similar to an S-curve where dark areas get lighter and light areas darker. Same as hard light with L_1 and L_2 commuted.



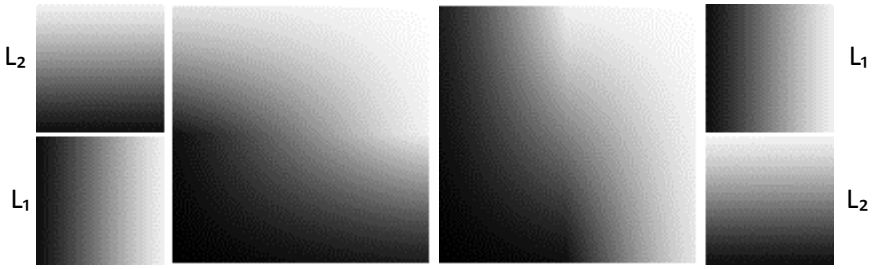
$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

Soft Light Multiplies the dark areas and screens the light areas. S-curve where dark areas get darker and light areas lighter.



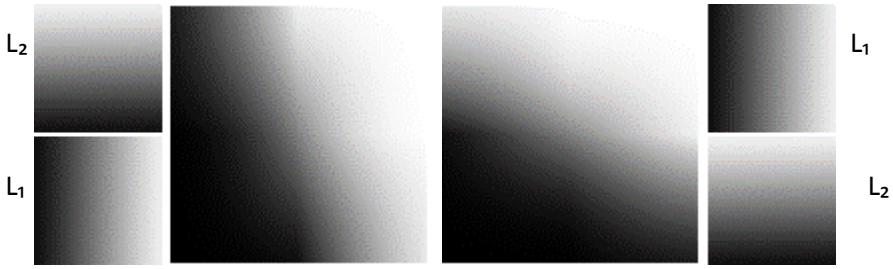
$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

Hard Light Multiplies the dark areas and screens the light areas. Stronger S-curve than soft light.



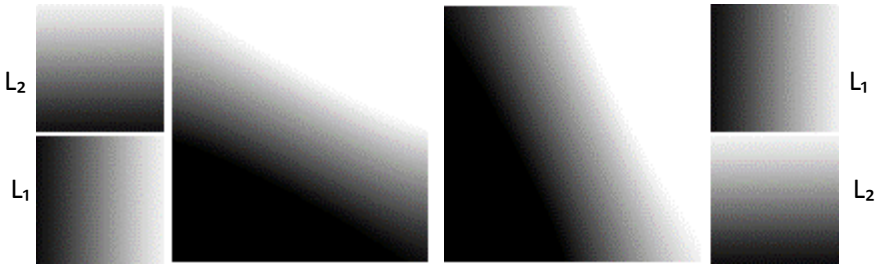
$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

Vivid Light Color dodge or color burn the previous image depending on whether the current image pixels are brighter or darker than neutral gray. Similar to hard light but with more intense results.



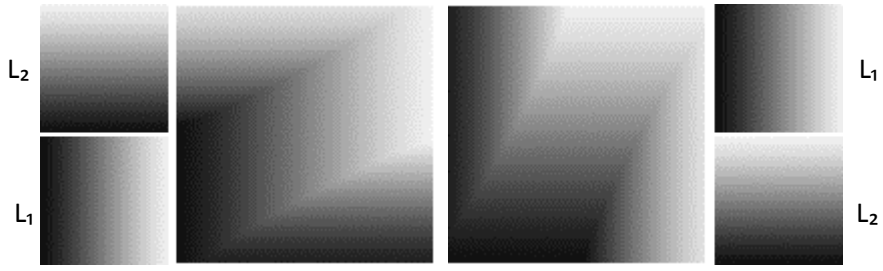
$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

Linear Light Linear dodge or linear burn the previous image depending on whether the current image pixels are brighter or darker than neutral gray. Similar to vivid light but with more intense results.



$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

Pin Light Multiply when the current image is darker than neutral gray otherwise use screen.

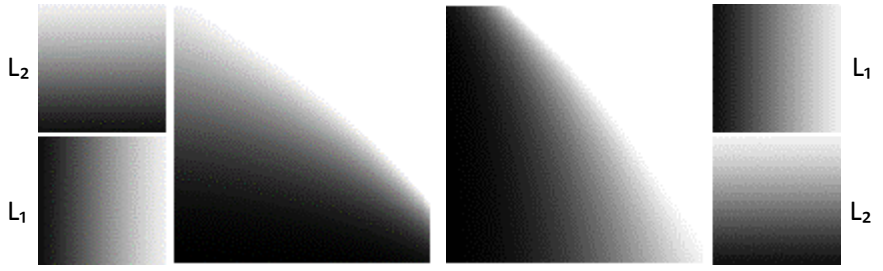


$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

Hard Mix Similar to linear light but with more intense results.

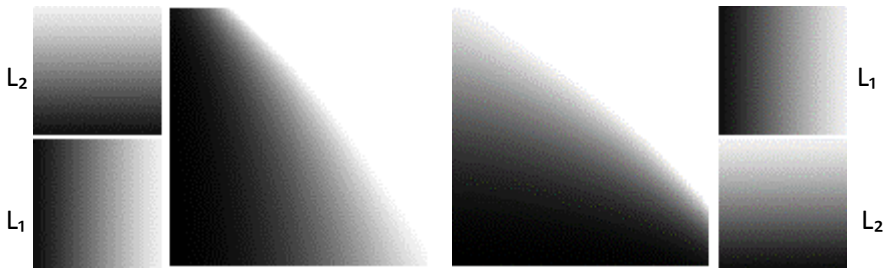
$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

Reflect Has the appearance of reflecting the current image off of the previous image.



$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

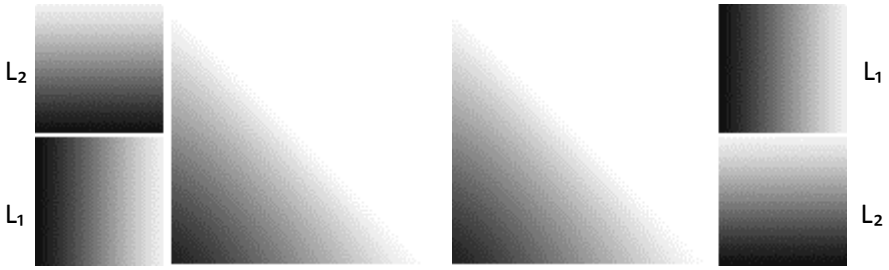
Glow Has the appearance of reflecting the previous image off of the current image.



$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

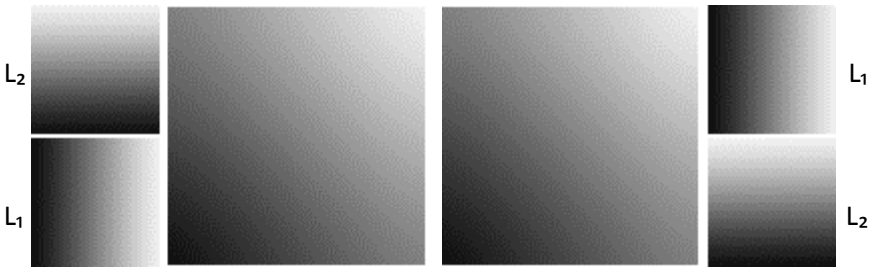
Arithmetic Blend Modes

Add Adds the current and previous image.



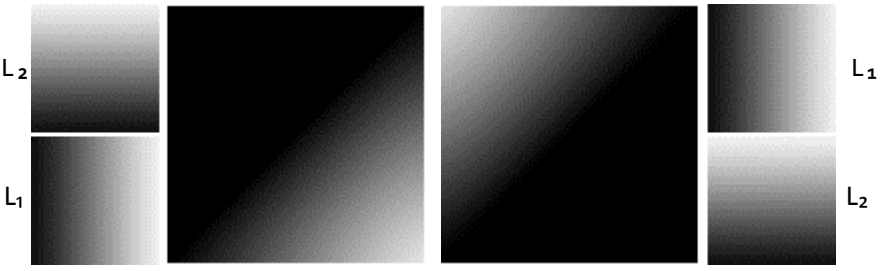
$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

Average Averages the current and previous image.



$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

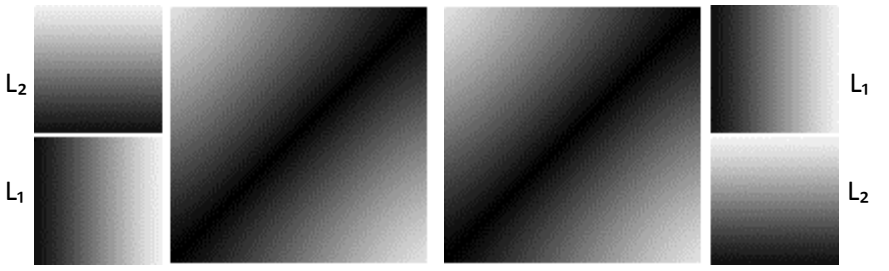
Subtract Subtracts the current image from the previous image.



$BM(L_1, L_2) \neq BM(L_2, L_1)$, not commutative

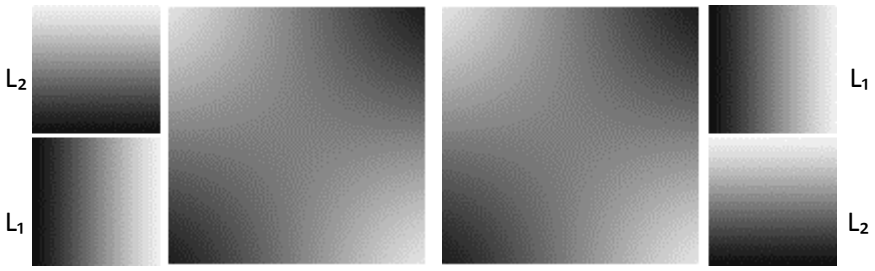
Inversion Blend Modes

Difference Subtract the current image from the previous image then uses the absolute value. Large difference is lighter than small difference.



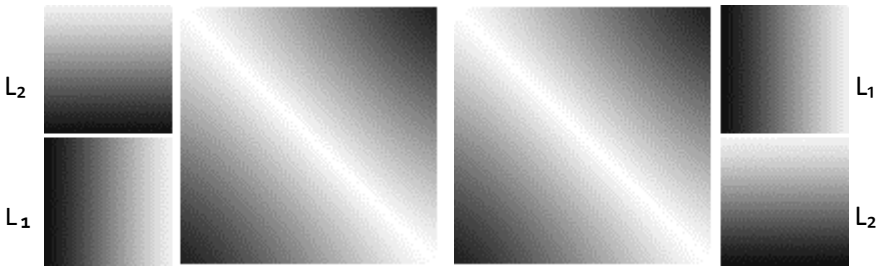
$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

Exclusion Previous image masks the difference between the current and previous image.



$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

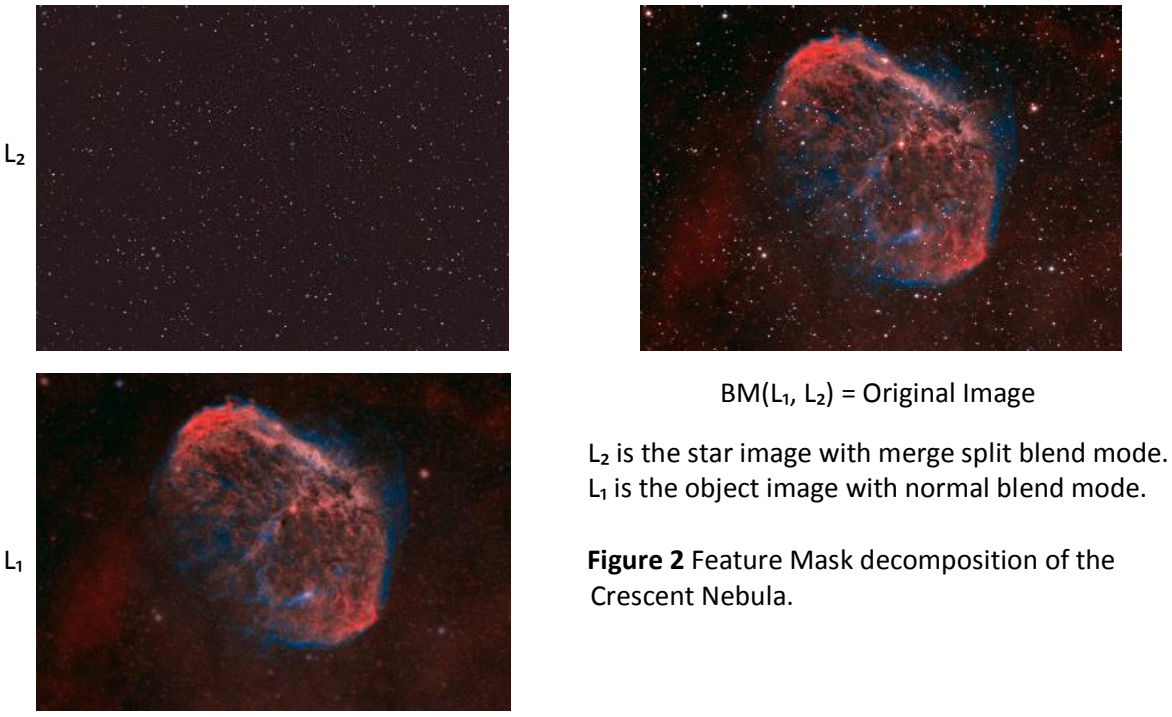
Negation White minus the absolute value of white minus current and previous image.



$BM(L_1, L_2) = BM(L_2, L_1)$, commutative

Multi Scale Decomposition Blend Modes

Merge Split The Feature Mask and Multi Scale Decomposition tools on the Special Functions menu in ImagesPlus split an image into component images with different detail or frequency levels. The component images can have both positive and negative pixel values. Merge Spilt blend mode uses the positive and negative pixel values of each component to rebuild the original image from its components without loss of detail or data. See Figure 2 and Figure 3 for examples of merge split blend mode.



$BM(L_1, L_2)$ = Original Image

L_2 is the star image with merge split blend mode.
L_1 is the object image with normal blend mode.

Figure 2 Feature Mask decomposition of the Crescent Nebula.

L_3

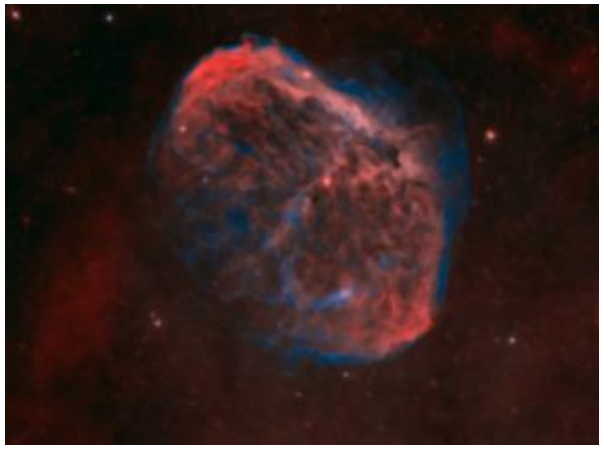
$BM(BM(L_1, L_2), L_3)$ = Original Image

L_2

L_3 is the highest frequency detail layer with merge split blend mode.

L_2 is the next larger detail layer with merge split blend mode. $BM(L_1, L_2)$ is the intermediate layer not shown.

L_1 is the low frequency residual layer after detail L_3 and L_2 are removed from the original image. L_1 has normal blend mode.



L_1

Figure 3 Multi Scale Decomposition of the Crescent Nebula into two high frequency detail layers L_3 and L_2 and a residual low frequency layer L_1.

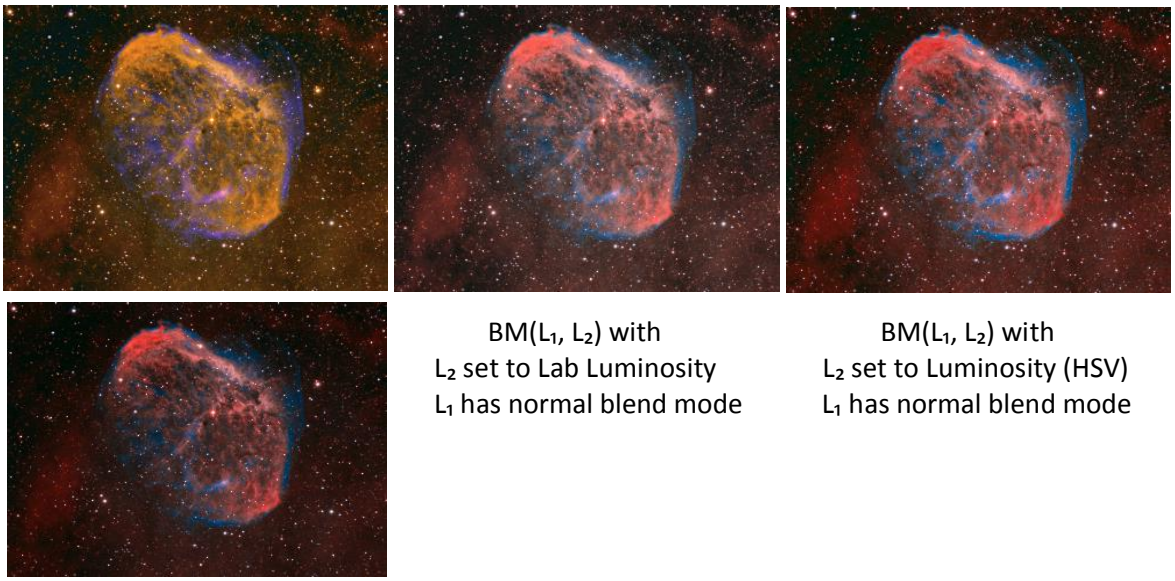
The 'Multi Scale Decomposition Tools in ImagesPlus' chapter of the concepts and user manual explains multi scale decomposition in detail.

HSV and Lab Color Blend Modes

HSV and Lab color blend modes are identical but produce slightly different results because HSV modes are performed with RGB data converted to HSV color and Lab blend modes are performed with RGB data converted to Lab color. See "Color Models & Color Tools in ImagesPlus" for a description of RGB, Lab, and HSV color models.

The Hue, Saturation, and Color blend modes are available only if both L_1 and L_2 are color RGB images. Both L_1 and L_2 are first converted from the RGB to HSV or Lab color then the hue, saturation, and luminance components of L_1 and L_2 are interchanged depending on the blend mode to create the new layer BM(L_1, L_2). The new layer BM(L_1, L_2) is then converted from HSV or Lab to RGB color.

Luminosity & Lab Luminosity Select luminance from the current image or top layer L_2. Hue and saturation are selected from the previous image or bottom layer L_1. L_2 has either Luminosity or Lab Luminosity blend mode set.



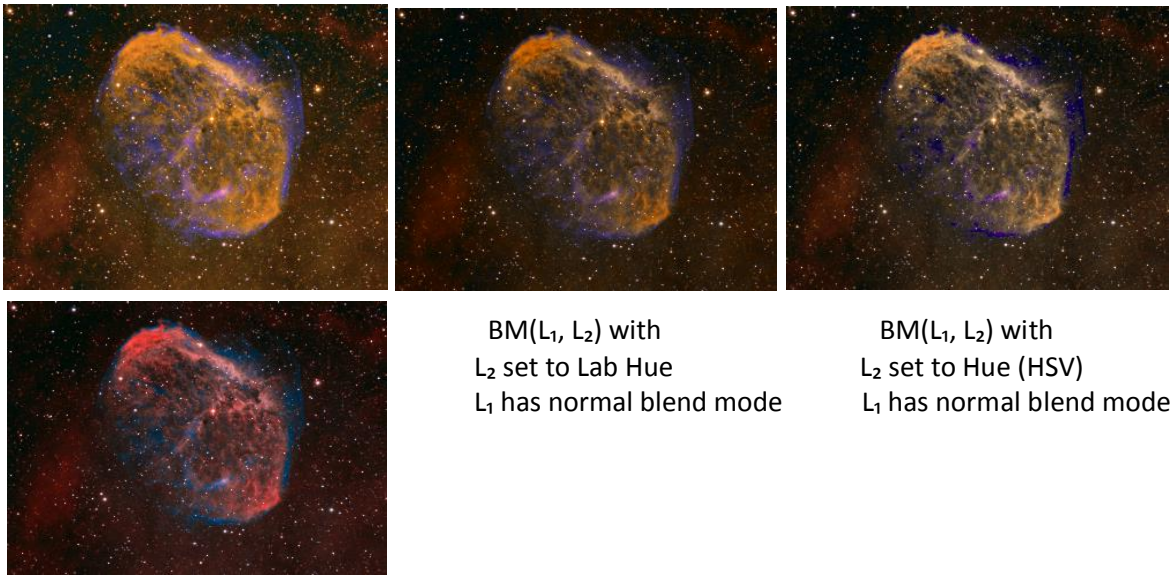
L_2

L_1

BM(L_1, L_2) with
L_2 set to Lab Luminosity
L_1 has normal blend mode

BM(L_1, L_2) with
L_2 set to Luminosity (HSV)
L_1 has normal blend mode

Hue & Lab Hue Select hue from the top or current image layer L_2. Saturation and luminance are selected from the bottom or previous image layer L_1.



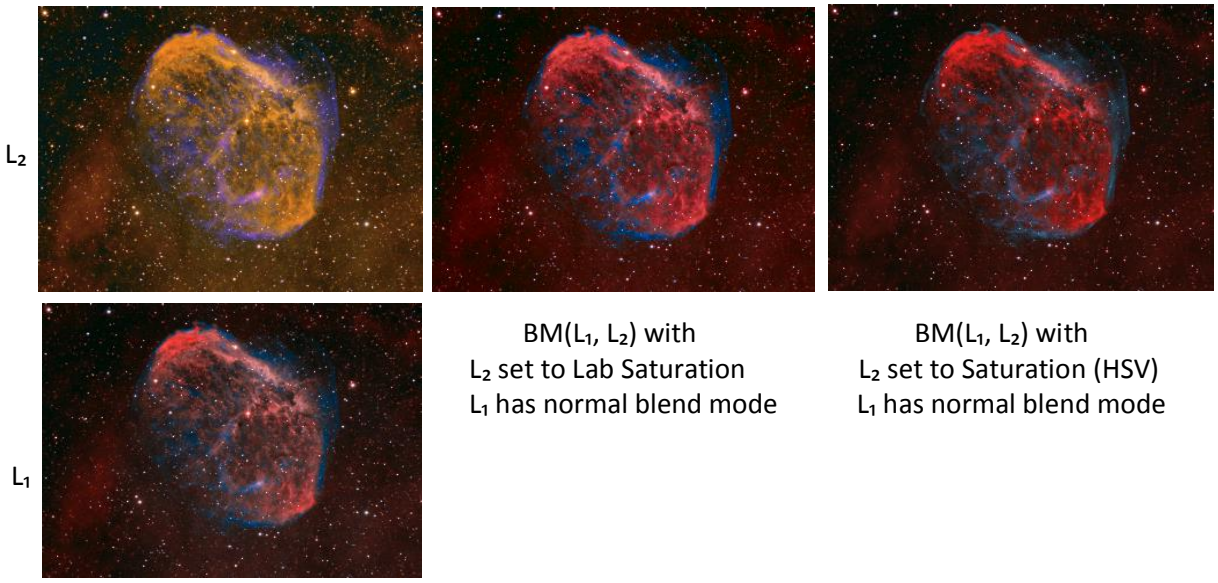
L_2

L_1

BM(L_1, L_2) with
L_2 set to Lab Hue
L_1 has normal blend mode

BM(L_1, L_2) with
L_2 set to Hue (HSV)
L_1 has normal blend mode

Saturation & Lab Saturation Select Saturation from the top or current image layer L_2. Hue and luminance are selected from the bottom or previous image layer L_1.



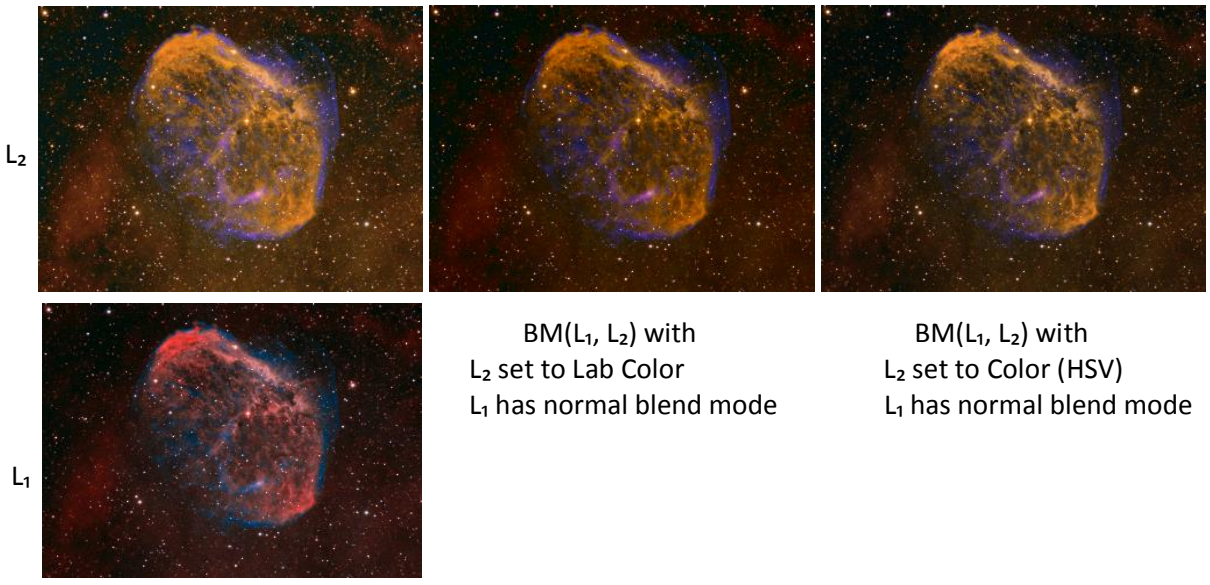
L_2

L_1

BM(L_1, L_2) with
L_2 set to Lab Saturation
L_1 has normal blend mode

BM(L_1, L_2) with
L_2 set to Saturation (HSV)
L_1 has normal blend mode

Color & Lab Color Select color (hue and saturation) from the top or current image layer L_2. Luminance is selected from the bottom or previous image layer L_1.



L_2

L_1

BM(L_1, L_2) with
L_2 set to Lab Color
L_1 has normal blend mode

BM(L_1, L_2) with
L_2 set to Color (HSV)
L_1 has normal blend mode

Implementation of Layers, Blend Modes, Opacity, & Mask in ImagesPlus

Layers, blend modes, opacity, and masks are all 32 bit floating point operations in ImagesPlus. ImagesPlus 5.0 and later has two tools that implement layers, blend modes, opacity, and masks. The Process History tool tracks the adjustment layers applied to each open image and allows opacity and a mask for each adjustment layer. Adjustment layers of an open image are created by applying stretch,

smooth, sharpen, deconvolution, color adjustment, and other special tools to the image. Figure 4 shows an open image with Hue-Saturation-Luminance followed by Micro Curves adjustment layers.

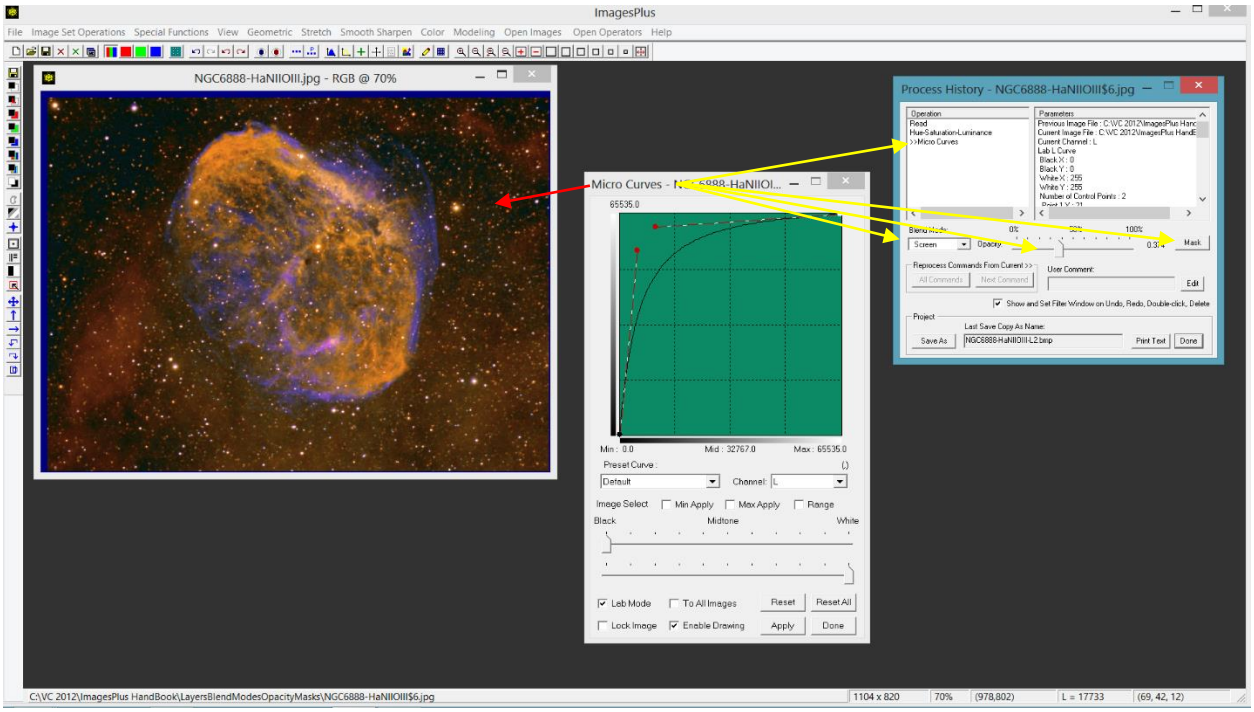


Figure 4 The Process History window on the main View menu or top horizontal toolbar records adjustment layers as they are applied to an open image. Apply a stretch, smooth, sharpen, deconvolution, color adjustment, or special function to the image to create a new adjustment layer. Next assign blend mode, opacity, and mask to the adjustment layer using the controls on the Process History window. In the above image Hue-Saturation-Luminance was applied to the image to create the first adjustment layer. Micro Curves was applied next to create the second adjustment layer then screen blend mode, opacity = 0.38, and mask are assigned using the controls on the Process History window. The red arrow shows which image Micro Curves is applied to and the yellow arrows show the Micro Curve adjustment layer in the Process History window with its blend mode, opacity, and mask set and display button.

The Combine Images tool on the Special Functions main menu is used to layer combine two or more open images each with its own sequence of adjustment layers with blend modes, opacity and masks which are tracked and accessed by using the Process History tool. Each image layer in the Combine Images layer tree can have its own blend mode, opacity and mask assigned using the controls on Combine Images. Figure 5 shows the Combine Images layer tree with two layers L_1 and L_2.

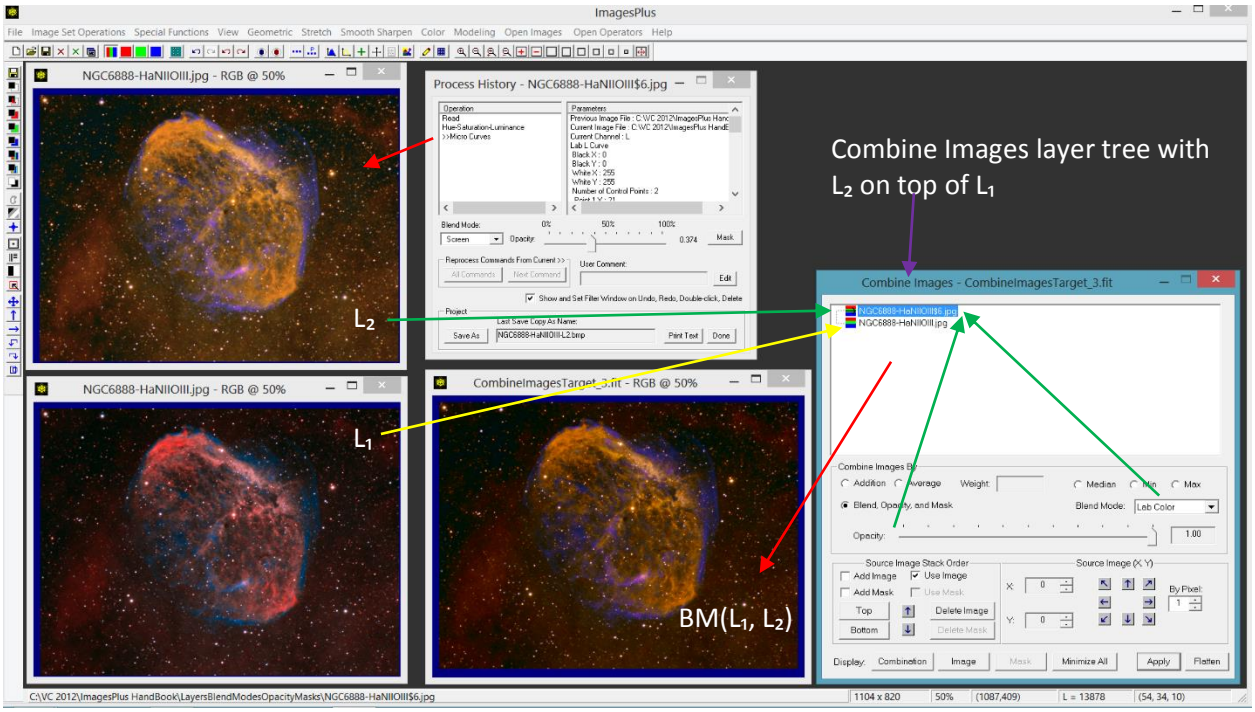


Figure 5 The Special Functions | Combine Images tool is used to blend two or more image layers where each layer is assigned a blend mode, opacity, and optional mask. Each image layer in the Combine Images layer tree has its own sequence of adjustment layers created by applying stretch, smooth, sharpen, deconvolution, color adjustment or other special functions with their own blend mode, opacity and mask. The adjustment layers are accessed and modified using the Process History tool shown in Figure 4. In the example above layer L_2 has a blend mode of Lab Color so Lab hue and saturation from L_2 are used with Lab luminance from layer L_1 to create the combination image $BM(L_1, L_2)$.

Using Process History Adjustment Layers

The Process History tool records the application of each adjustment filter with its own blend mode, opacity, and mask as it is applied to each open image. Open an image then open the Process History window using its button on the top horizontal tool bar. The first image layer shown in Figure 6 at the top of the Operation list of Process History is >>*Read* since the image was just opened and was read from the hard drive. The prefix >> marks the current active adjustment layer in the Operation list.

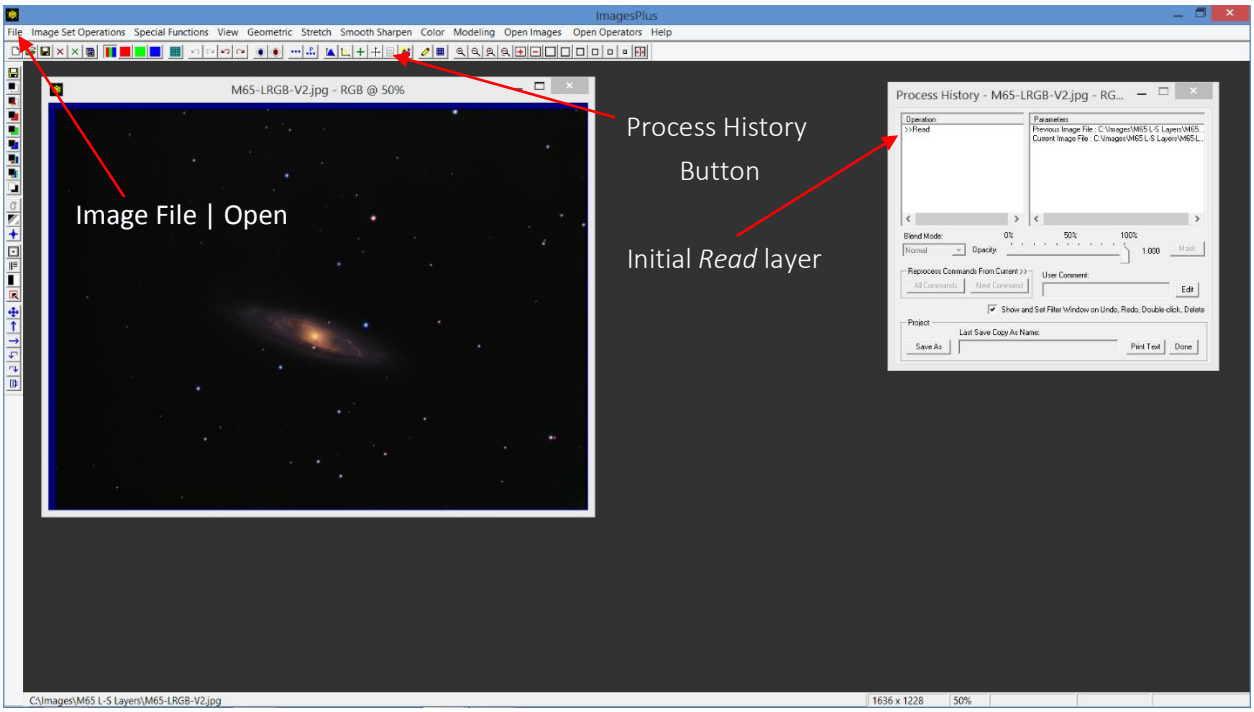


Figure 6 Process History in its initial state when an image is first opened. >>Read is the first layer where the prefix >> is used to point to the current active adjustment layer in the Operation list.

Open an adjustment filter such as Micro Curves from the Stretch menu and apply a mild luminance increase to the image. A new adjustment layer called Micro Curves is add to the Operation list of Process History with default values of *normal* blend mode, opacity = 100%, and no mask assigned. The current adjustment layer is marked by a prefix of **>>** in the Operation list of the Process History window so >>Micro Curves appears. After an adjustment layer is created the default value for blend mode, opacity, and mask can be changed. Figure 7 shows the blend mode of the Micro Curves adjustment layer set to *screen* and opacity set to 0.690 on the Process History window.

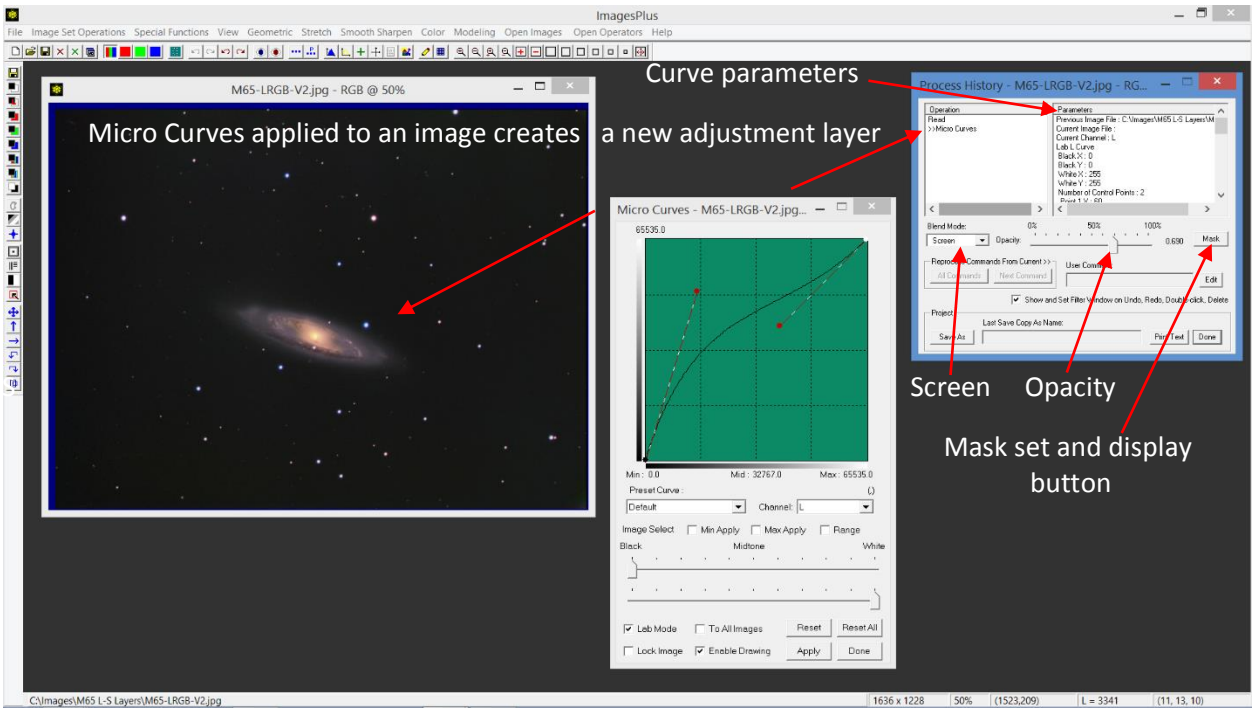


Figure 7 The current adjustment layer pointed to by >> is displayed by the Process History window as **>>Micro Curves** and is shown as the second adjustment layer in the Operation list. Screen blend mode and opacity = 0.690 have been set but no mask has been assigned to the current Micro Curves adjustment layer. The Parameters list of the Process History window records all parameters used by an adjustment layer filter.

A mask can be assigned to the current adjustment layer. A mask made from an image in ImagesPlus is always a single channel gray scale image with the same pixel width and height as the image layer that the mask is assigned to. A mask can be created many different ways using the mask tools covered in the Making and Using Masks chapter. No matter how an image mask is created the mask is always assigned to an adjustment layer in the Process History window using the following steps.

1) A grays scale mask is created using the mask tools or a luminance version of an image. In this case to create a luminance mask first select a color image using the mouse then press the *Luminance* or *Lab Luminance* button on the left vertical toolbar to create a gray scale image. See the yellow arrow in Figure 8.
2) Press the *Save As and Copy Mask* button at the top of the left vertical toolbar and give the mask a descriptive name then save it in 16 or 32 bit floating point FITS format. The gray scale mask is now the current system mask and can be assigned to an adjustment layer in the Process History list. See the green arrow in Figure 8. The *Save As – Copy Mask* button on the Selective Color Mask and Custom Luminance Mask tools will assign a system mask.
3) Press the *Mask* button on Process History to display the Mask Surface window then right click on the white rectangle and select *Paste Mask* to assign the current system mask to the adjustment layer. The *Load* button on the Mask Surface tool can be used to load a mask image from your hard drive. See the blue arrow in Figure 8.

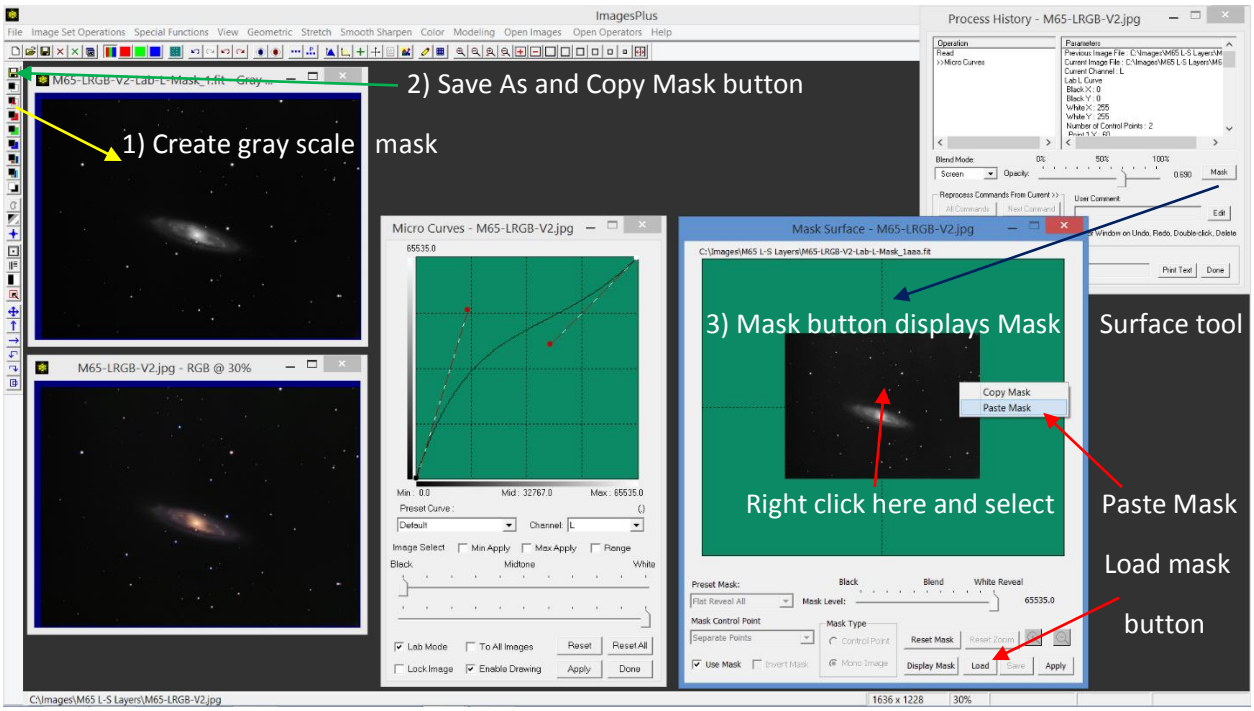


Figure 8 Steps to assign an image mask to an adjustment layer in the Process History Operations list. 1) In this case a luminance mask is created using the *Luminance* tool bar button. 2) The image mask is saved to the hard drive and set as the current system mask using the *Save As and Copy Mask* toolbar button. 3) Press the *Mask* button on Process History to display the Mask Surface tool then left click on the image rectangle and select *Paste Mask* to assign the mask to the Micro Curves adjustment layer.

The Process History list now has two adjustment layers. Read is the first layer L_1 followed by Micro Curves layer L_2 with screen blend mode, opacity = 0.690, and an image mask as shown by Figure 9. Suppose Micro Curves is to be used again but this time to increase blue in the outer spiral arm of M65. It is important to press the *Set View* button on the top horizontal toolbar to save the first Micro Curves adjustment layer L_2 before applying the blue adjustment using Micro Curves otherwise ImagesPlus will think you are changing the first application of Micro Curves.

The Set View button on the top horizontal toolbar must be pressed to save an adjustment layer before the same adjustment filter with different parameters can be applied next.

If a different adjustment filter is applied then ImagesPlus will automatically save the current adjustment layer before the next filter is applied. In this case the Set View button does not need to be used.

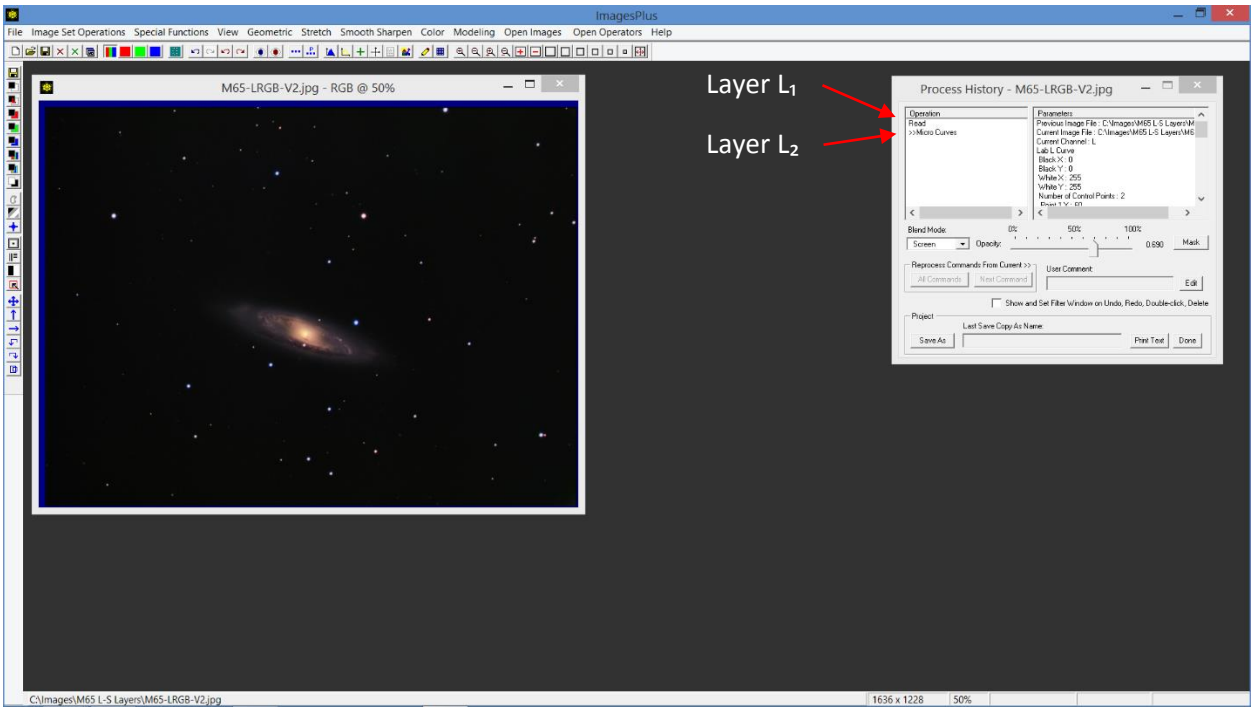


Figure 9 Image after Micro Curve adjustment layer L_2 is applied to brighten M65.

For example, follow these steps to apply Micro Curves as layer L_3 to add blue to the spiral arms of M65 right after Micro Curves was used to create layer L_2.

1) Press the Set View toolbar button to save the current Micro Curves adjustment L_2 before Micro Curves is used again to increase blue by adding a new adjustment layer L_3.

2) Apply Micro Curves in Lab mode and increase blue using the Lab b curve. Blue is increased in the spiral arms but also in the dark background. A mask should be used to limit the blue increase to just the spiral arms of M65.

3) The same luminance image mask used with the first application of Micro Curves in layer L_2 can be used to restrict Micro Curves to M65 when adjusting blue in layer L_3. The system mask available for use with an adjustment layer in Process History does not change until you set a new system mask using the *Save As and Copy Mask* button. The system mask does need to be assigned to each adjustment layer that you want to use the mask.

Figures 10 and 11 demonstrate the above three steps.

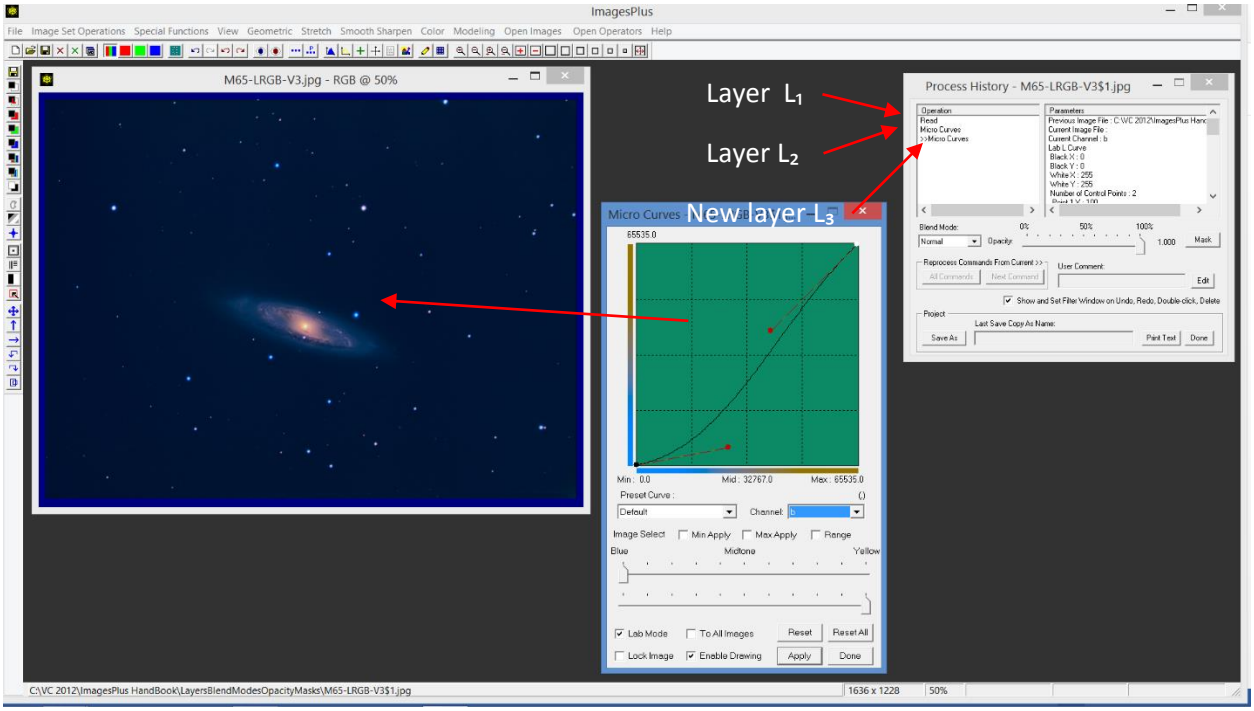


Figure 10 Micro Curves is applied in Lab mode to increase blue by creating a new adjustment layer L_3. Blend mode is set to *Normal* and opacity is set to 100% when the adjustment layer is created. No mask is assigned to the new adjustment layer L_3 when it is created.

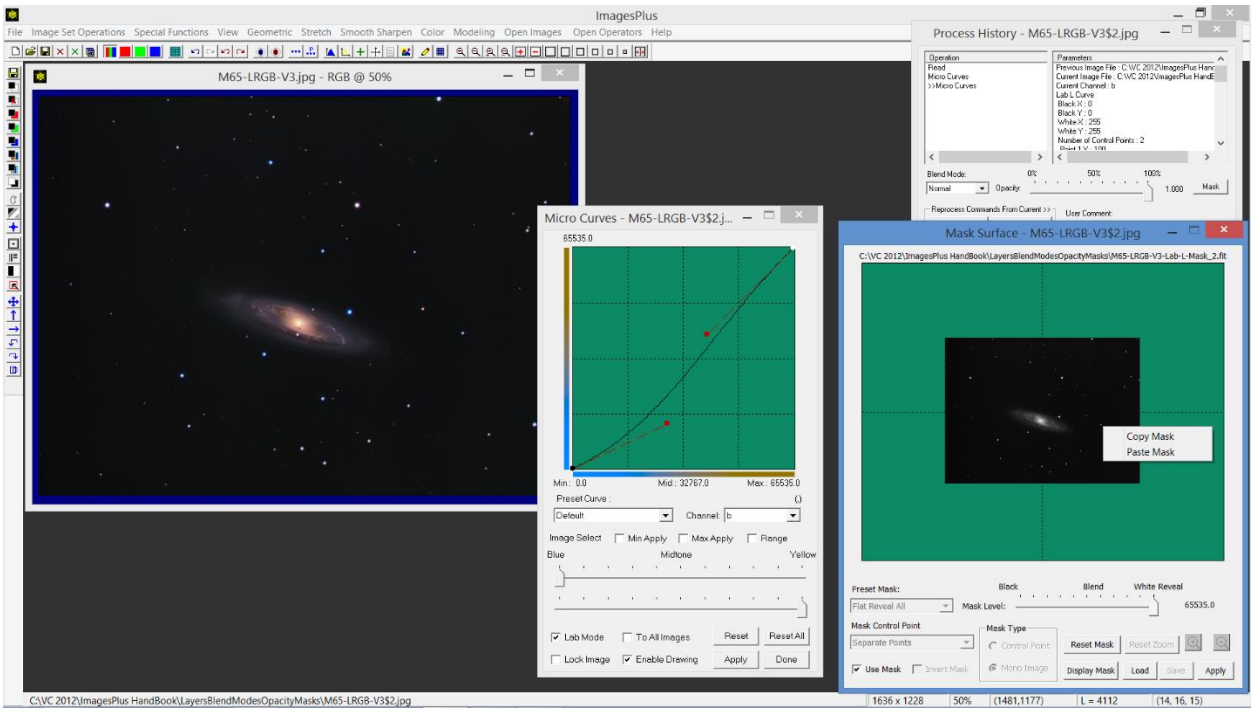


Figure 11 Press the *Mask* button on Process History to display the Mask Surface window then right-click on the mask image rectangle and select *Paste Mask* to assign the current system mask. The mask restricts Micro Curves so that only blue stars and the spiral arms of M65 have increased blue.

Undo, Redo, and Double-Click

After a few filters have been applied to an image and you have 2 or more adjustment layers in the Operation list of Process History the *Undo* and *Redo* toolbar buttons can be used to step backward and forward sequentially through the adjustment layers. If you want to jump to a particular adjustment layer then double left-click on the adjustment layer in the Operations list. Remember that the current adjustment layer is marked by a prefix of >>. *Undo, Redo, and* double left-click on a layer will display the state of the image at the current adjustment layer and will display the tool along with the parameters that were applied. If you want to review the different adjustment layers of an image without the tool that created each layer appearing then uncheck the *Show and Set Filter Window on Undo, Redo, Double Click, Delete* box on the Process History window.

Adjustment layers can be easily modified.

1) First make sure the *Show and Set Filter Window on Undo, Redo, Double Click, Delete* box is checked on the Process History window so that the filter tool is displayed and set to the parameters used to create the layer. Now use *Undo, Redo,* or double left-click on the layer that you want to modify so that it is the current layer marked with the >> prefix. See Figure 12 for an example.

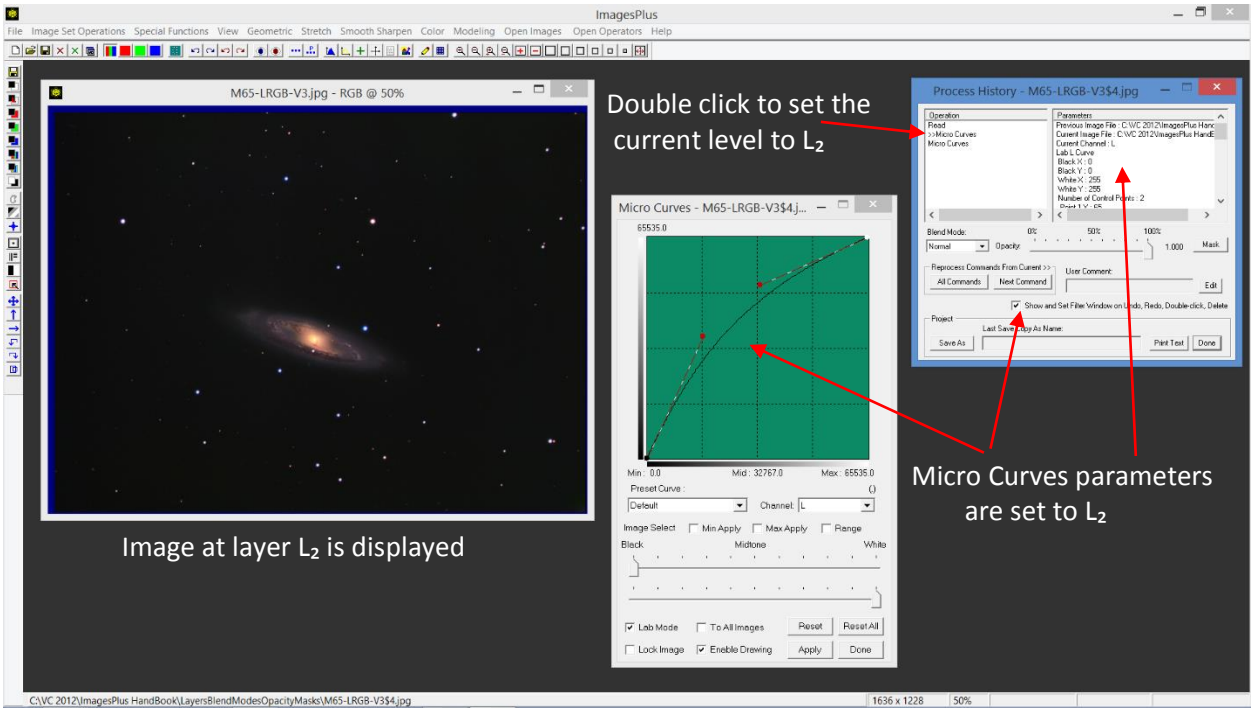


Figure 12 In Figures 10 and 11 adjustment layer L_3 is the current layer where Micro Curves is used to adjust blue. To modify layer L_2 where Micro Curves is used to increase the luminance of the image double click on L_2 or use *Undo* to set L_2 as the current layer. The Micro Curves tool is set to the parameters used in layer L_2 since the *Show and Set Filter Window on Undo* is checked.

2) Change the filter tool parameters, blend mode, opacity, and mask as needed to modify the image. After you change the parameters and reapply the filter tool all adjustment layers after the current layer marked with >> will need to be updated using the change to the current layer. See Figure 13.

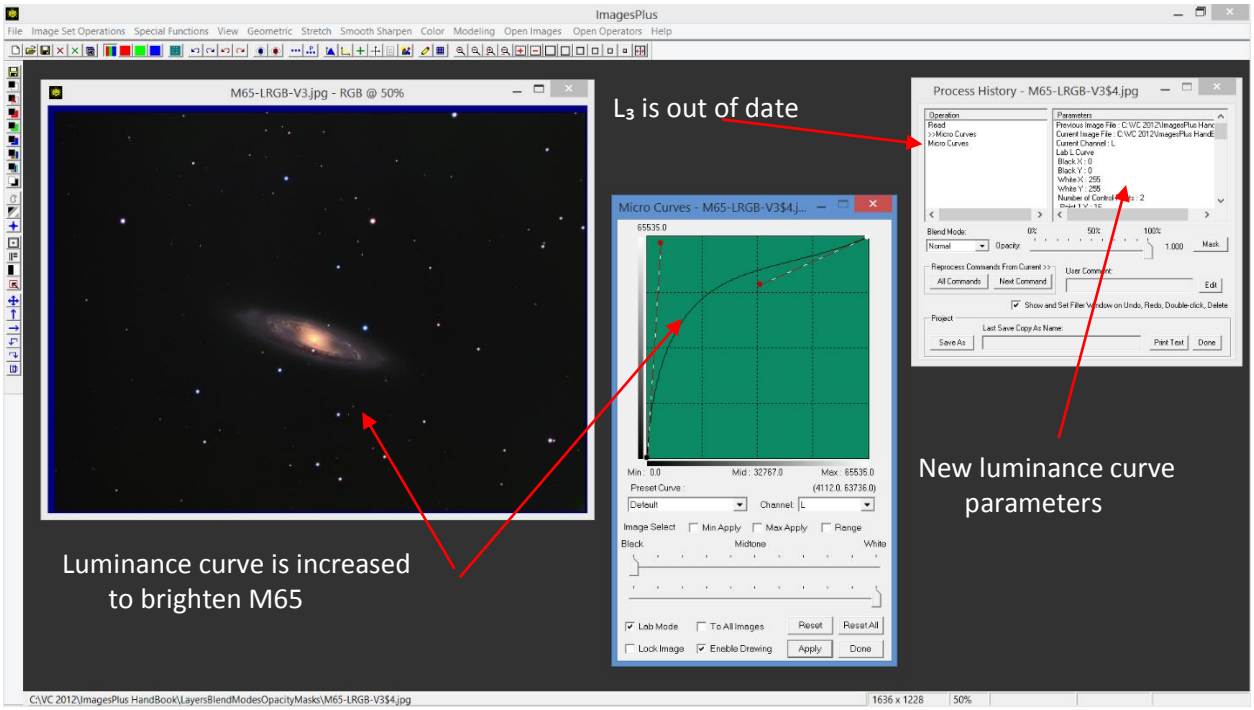


Figure 13 Luminance curve of layer L_2 is increased to brighten the outer arms of M65. Micro Curves layer L_3 is now out of date since it does not use the increased luminance curve of layer L_2.

3) Press the *Next Command* button on the Process History window to update the next adjustment layer. Adjustment layers that need to be updated will be marked with a prefix of ~~. Continue pressing the *Next Command* button or press the *All Commands* button to update every adjustment layer after a modified adjustment layer.

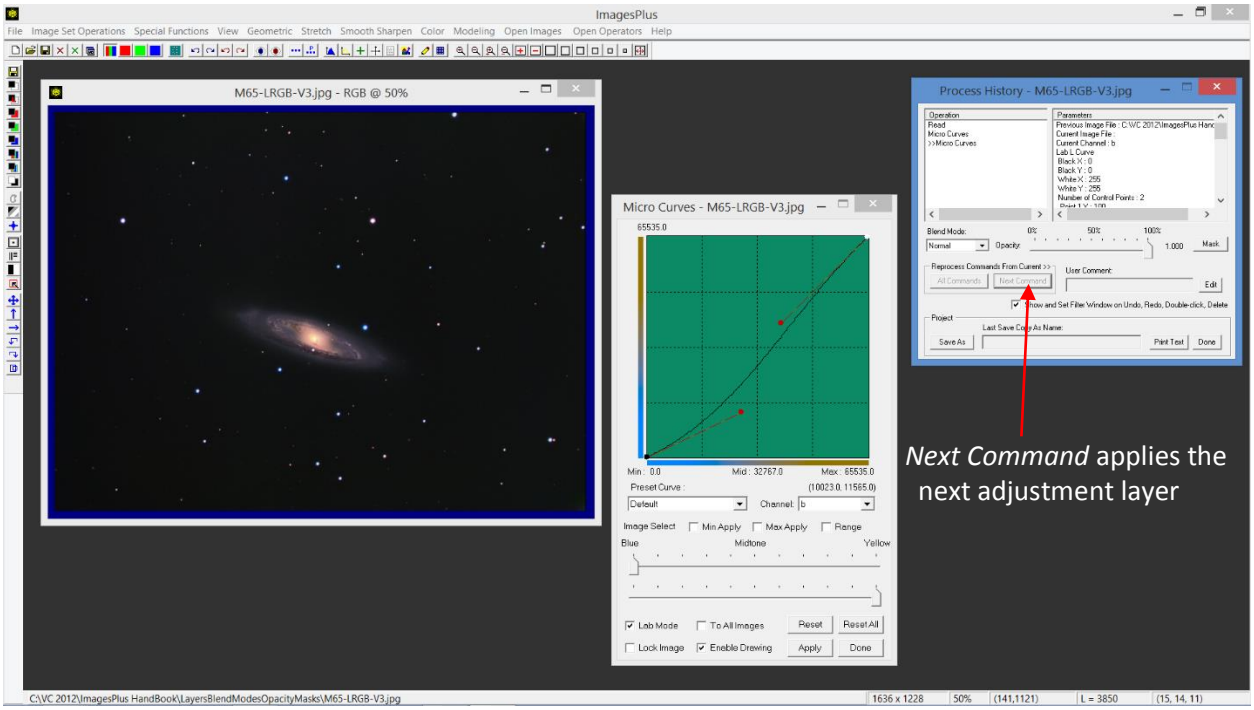


Figure 14 Use the *Next Command* button to apply layer L_3 to the modified L_2 layer.

Out of date adjustment layers can be deleted rather than updated. Use Ctrl + left click on the out of date layers to select them then right-click on the layers and select delete.

A new adjustment layer can be inserted anywhere in the Operation list.

1) Use *Undo, Redo,* or double click to select the adjustment layer in the Operation list where you want to insert a new adjustment layer. See Figure 15.

2) Open a filter tool and apply it to the image. The new filter adjustment layer will be inserted after the layer selected in step 1. See Figure 16.

3) The next adjustment layer after the new layer inserted in step 2 will have a prefix of ~~ to indicate that it needs to be updated. Use the *All Commands* or *Next* Commands button on the Process History window to update all of the layers after the inserted layer. See Figure 17.

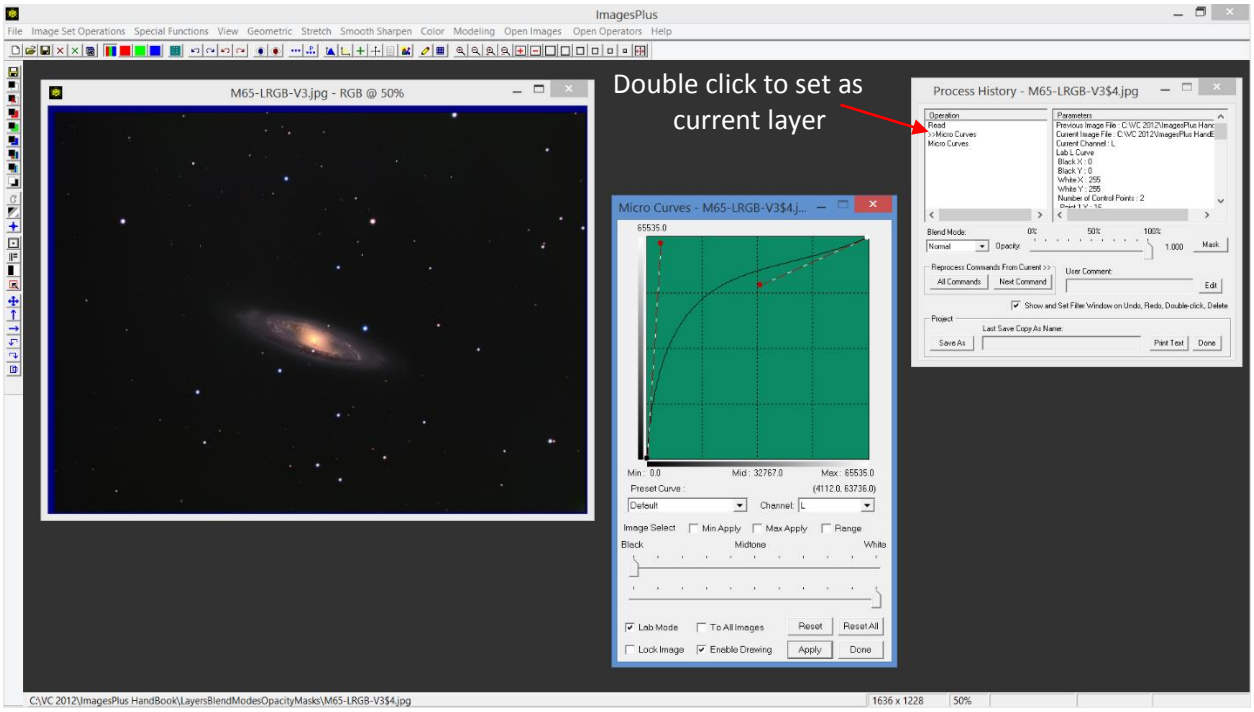


Figure 15 Double click on the first Micro Curves layer to set it as the current layer marked by >>. Deconvolution sharpening will be inserted after the first Micro Curves.

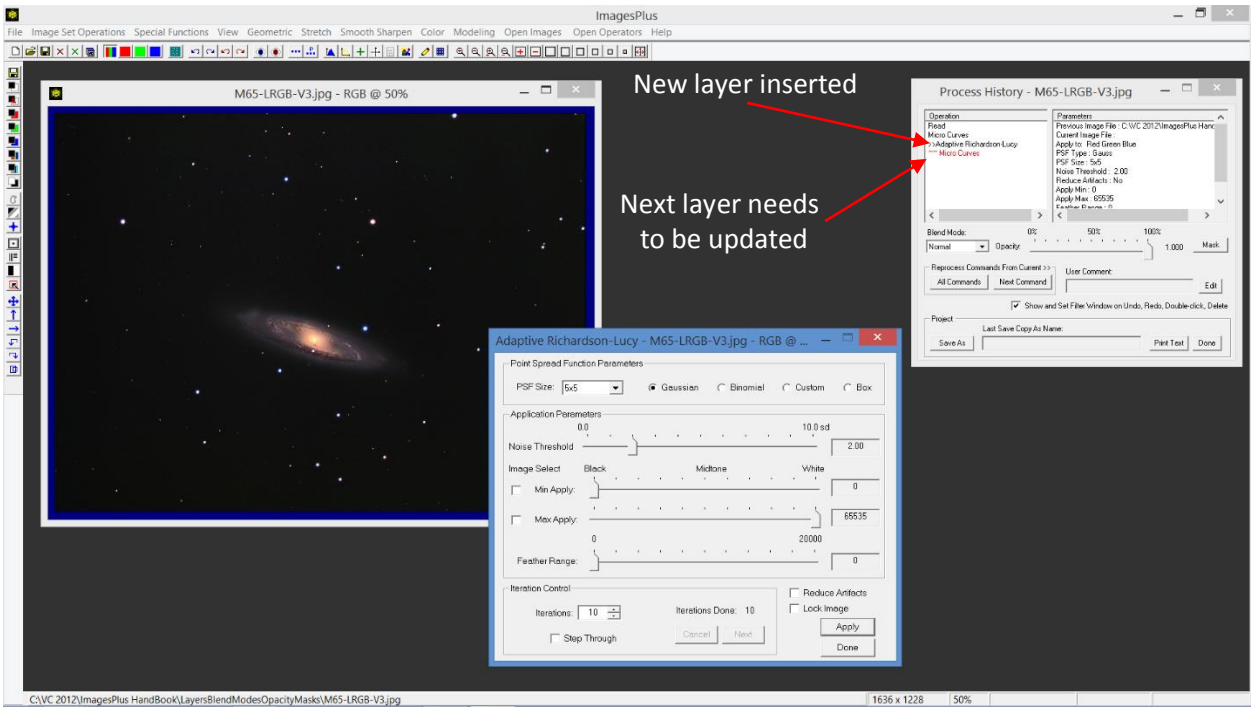


Figure 16 Open a filter and apply it to the image to insert the filter as a new adjustment layer. In this case Adaptive Richardson-Lucy deconvolution is applied to the image to sharpen it. The Adaptive Richardson-Lucy layer is inserted after the first Micro Curves layer. The layer after the Adaptive Richardson-Lucy layer is marked with ~~ to indicate that the layer needs to be updated.

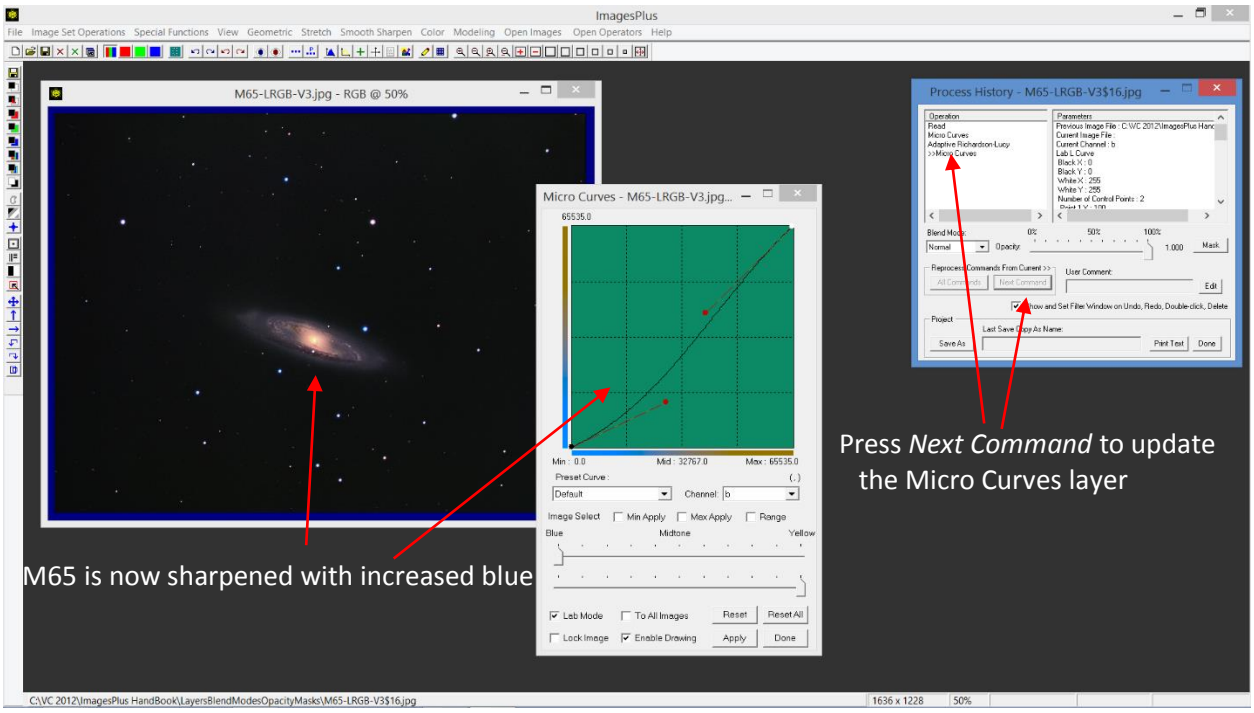


Figure 17 Press the *Next Command* button to update the Micro Curves layer using the sharpened image of M65.

One or more adjustment layers can be cut, copied, paste, or deleted.

1) Use Ctrl + left click to select on or more layers in the Operation list of Process History.

2) Right-click on the selected layers and select *Cut, Copy, or Delete. Cute* will copy the adjustment layer tool parameters, blend mode, opacity, and mask to the ImagesPlus clip board before the layers are deleted. *Copy* will copy the adjustment layers so they can be inserted into the operation list of the same image or a different image. *Delete* will remove the selected layers from the operation list of the current image.

3) If *Cut* or *Copy* is used first then the adjustment layers can be inserted into the operation list of the current image or a different image. In the Operation list select the adjustment layer where you want to insert the copied adjustment layers then right-click on the layer list and select *Paste.* The copied layers will be inserted after the current layer with a prefix of >>. Use the *Next Command* or *All Commands* button to update all layers after the layer where the commands were inserted.

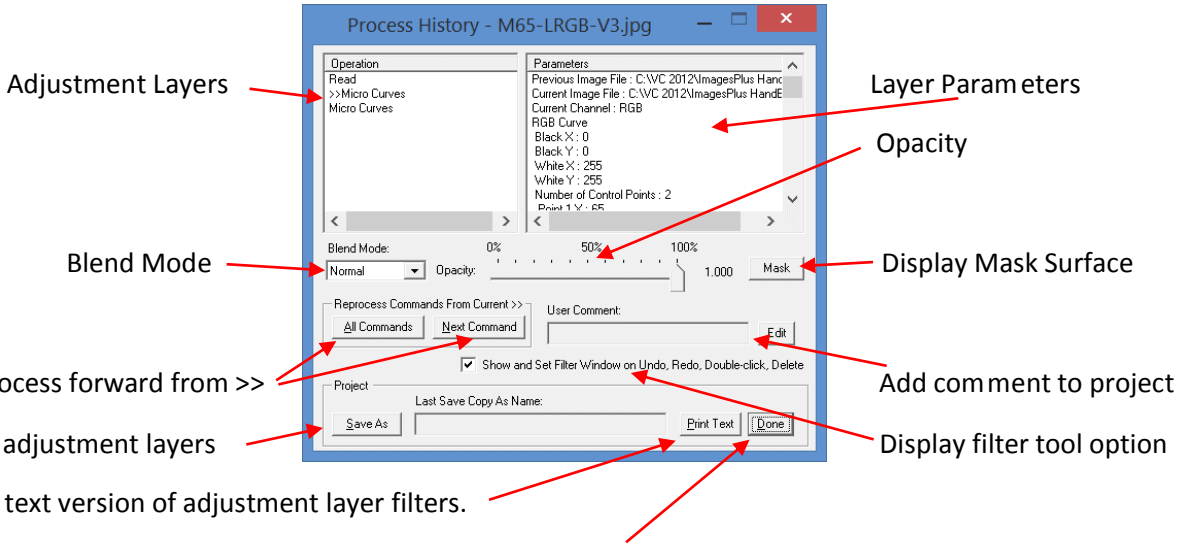
A Process History project file can be used to save and load a sequence of adjustment layers.

1) To save the adjustment layers to a project file press the *Save As* button on the Process History window then name the current image.

2) The Project Save parameters window will automatically appear next. Enter a name for the project and also select a folder for the project. Press OK to save all layer tool parameters with their blend modes opacity, and masks. The project file will have an extension of .IPJ.

3) Use File | Load Project to restore the adjustment layers from an ImagesPlus project file. The adjustment layers can be modified, copied, or deleted.

Process History Summary



Using the Mask Surface Window

The Mask Surface window is used to assign a mask to an adjustment layer in the Process History window. The Mask Surface window supports image masks as shown above in Figures 7, 8, 9, 10 and 11. The Mask Surface window also supports control point masks.

A control point mask is a synthetic mask with sixteen red control points. The control points are similar to the controls points used by Micro Curves and adjust the gray scale level of the mask. Control point masks are useful when dealing with a bright or dark corner, edge, or other local area of an image. A control point mask can be used to create a mask that targets the local problem area of an image using the following steps.

1) Apply a filter to correct the defect and create an adjustment layer. The filter will modify the entire image. The control point mask will be used to restrict the filter to just the problem area of the image.

2) Open the Process History window and press the *Mask* button to open the Mask Surface window.

3) On the Mask Surface window set the *Mask Level* to black then adjust the control points with the mouse to generate a mask with gray to white in the same area of the image that needs to be corrected. *Remember black mask areas conceal the current adjustment layer and reveal the previous layer, white mask areas conceal the previous layer and reveal the current layer, and gray mask areas mix the previous and current layers proportional to the gray level.* To adjust the mask gray level around a control point left click on the control point and drag the mouse up or down. Hold the Shift key down and place the mouse over a control point then left click to move the control point sideways to a new (x, y) position in the mask.

See Figures 18, 19, and 20 for an example.

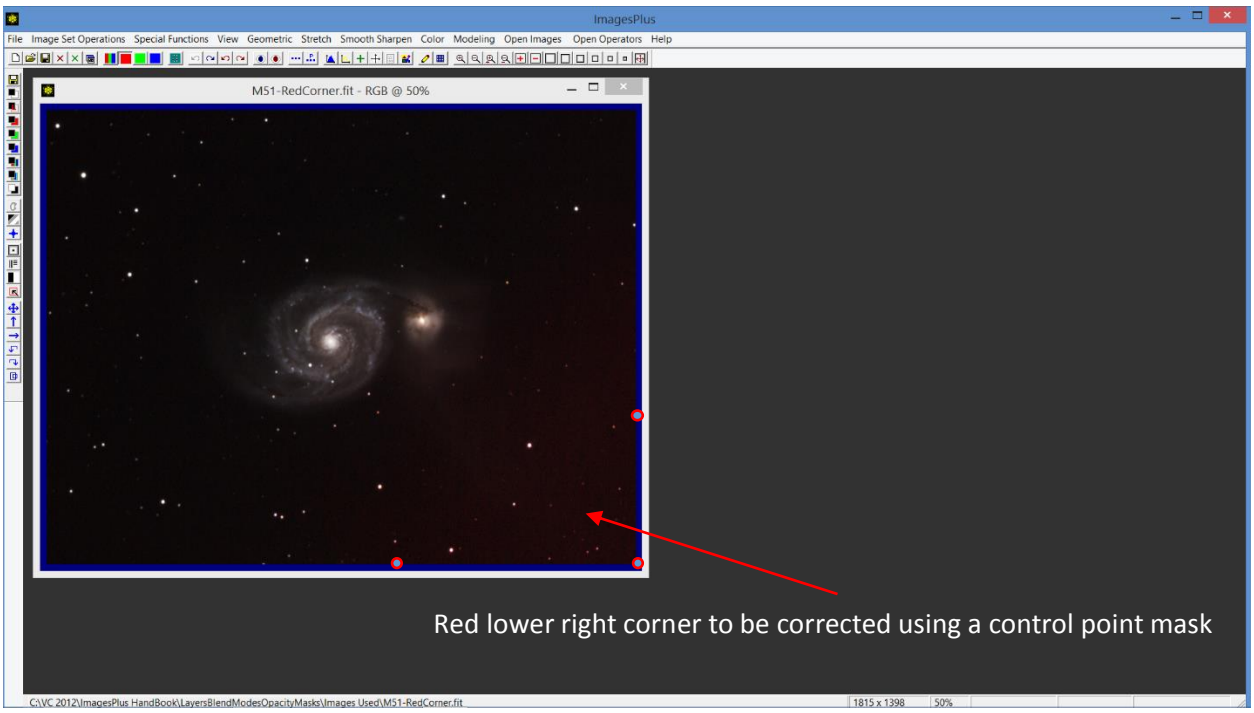


Figure 18 The above image has a red glow in the lower right corner. A control point mask can easily be generated to match the red region in the lower right corner of the image.

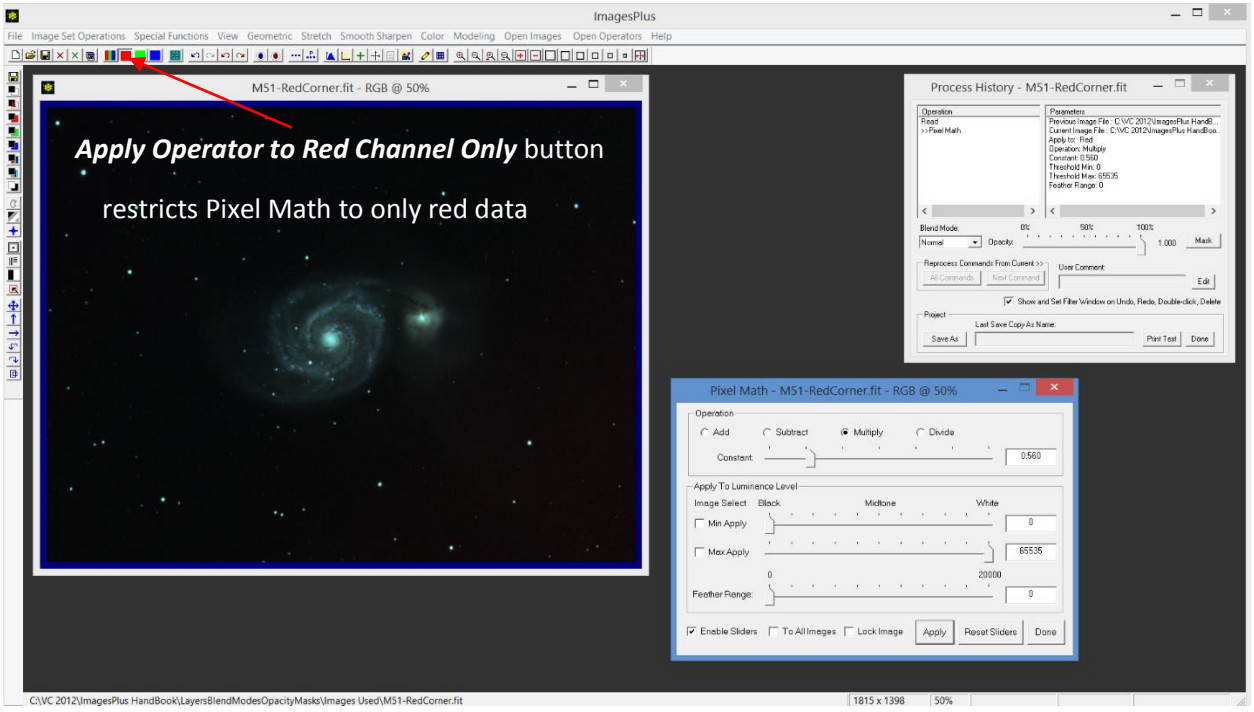


Figure 19 Pixel Math is used to multiply red data by a factor of 0.560. Red is reduced in the lower right corner but without a mask red in the entire image is also reduce so M51 and the stars appear cyan.

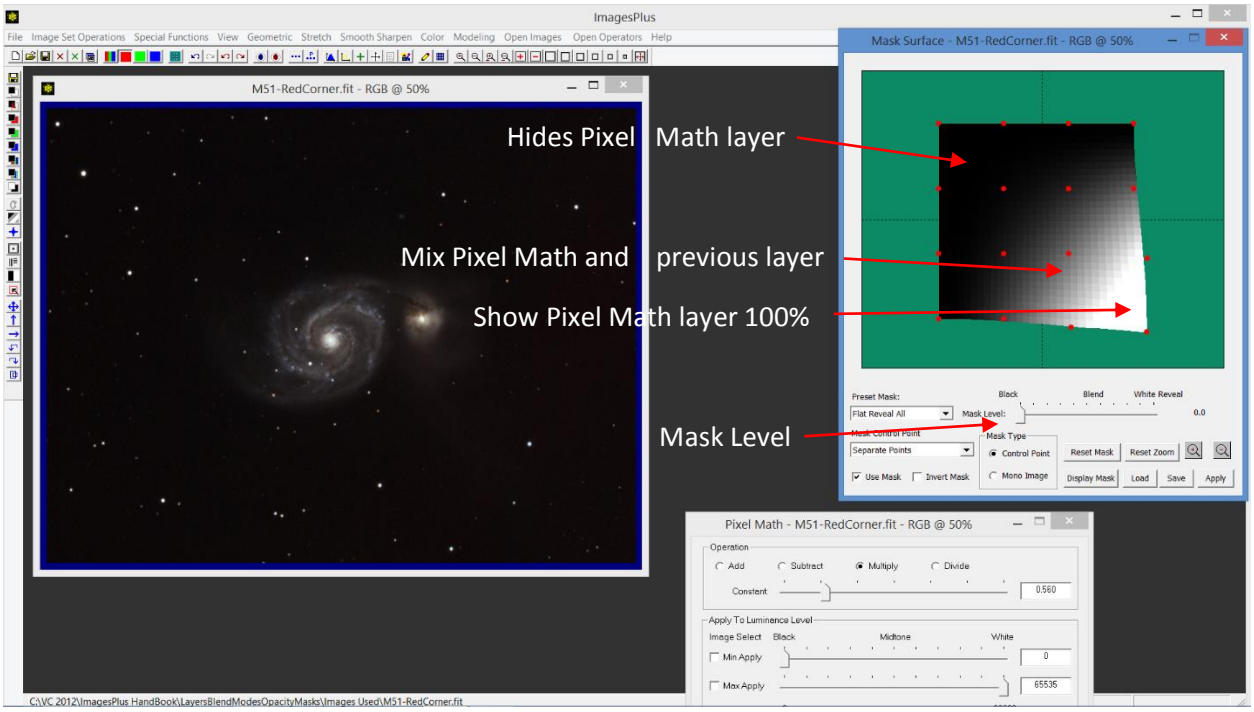
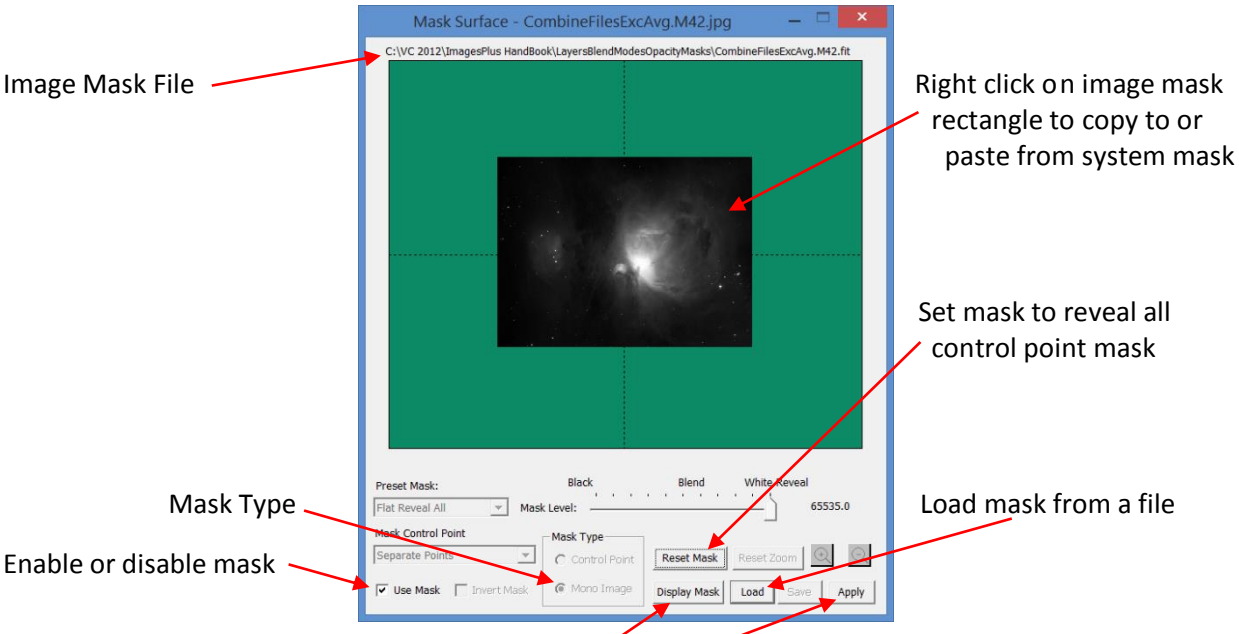


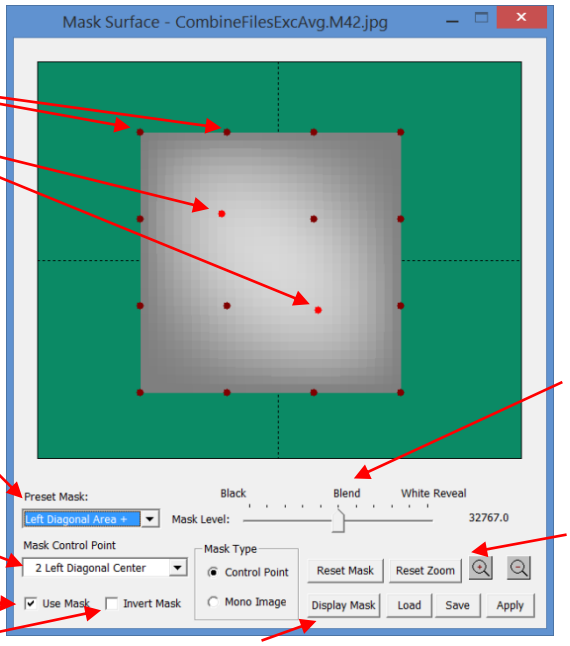
Figure 20 First the *Mask Level* is set to black to create a black mask that hides the Pixel Math adjustment layer and reveals all of the initial image layer with red lower right corner. The three lower right control points are now adjusted with the mouse to make the lower right corner of the mask white so that Pixel Math reduces red.

Mask Surface Image Mask Summary



Display image mask as an image so it can be modified using any filter tool. Use File | Save to save the changes to the mask file then press the *Apply* button to apply the modified mask to the layer.

Mask Surface Control Point Summary



Dark red disabled

Bright red enabled

Preset control points

Enable control points to move as a group or separate

Enable or disable mask

Invert mask

Initial gray mask level

Zoom mask display

Display control point mask as an image mask so it can be processed

Using Combine Images Layers

The Combine Images tool on the Special Functions menu is used to blend two or more image layers where each layer is assigned a blend mode, opacity, and optional mask. The image layers do not need to have the same pixel width or height. Color and monochrome images can be used as image layers. Each image layer in the Combine Images layer tree has its own sequence of adjustment layers created by applying stretch, smooth, sharpen, deconvolution, color adjustment or other special functions with their own blend mode, opacity and mask. The Process History tool is used to manage the adjustment layers of each image layer used by Combine Images. See Figure 5.

Adding Image Layers

All open images can be automatically added to the layer tree of Combine Images in the order that the images were opened using Special Functions | Combine All Open Images Using. The combination methods include Add, Average, Median, Minimum, Maximum, or Blend Mode, Opacity, and Masks. The top left corner of each open image is placed at the top left corner of the combination image.

Special Functions | Manual Combine Images Setup allows you to select each open image that you want to include and also where it is initially placed in the combination image. Follow these steps to add an open image to the top of the Combine Images layer tree.

1) Open Special Functions | Manual Combine Images Setup then enter a name for the combination image. The initial combination image size will be set to the size of the current active open image. You can enter smaller or large width and height for the combinations image if you are building a mosaic.

2) Check the *Add Image* box on Combine Images then left click on the open image to add it to the top of the layer tree. The top left corner of the image will be positioned at the top left corner of the combination image. To place the image at a different position left click and hold on a feature in the image then release the left mouse button on the position in the combination image where you want the feature to appear. The *Use Image* check box will enable and disable the image layer.

Adding a Mask to an Image Layer

1) Open or create a single channel gray scale image mask using the mask tools.

2) Left click to select the image layer in the layer tree of Combine Images where the mask will be assigned. The current layer in the layer tree is marked by → through the color icon of the layer. You can also left click on the open image window to set it as the current image layer in the layer tree.

3) Check the *Add Mask* box on Combine Images then left click on the single channel gray scale mask image. The mask image must have the same pixel width and height as the image layer that it is assigned to. The *Use Mask* check box will enable and disable the mask.

Assigning Blend Mode and Opacity to an Image Layer

1) Left click to select the image layer in the layer tree of Combine Images where blend mode and opacity will be assigned. The current layer in the layer tree is marked by → through the color icon of the layer. You can also left click on the open image window to set it as the current image layer in the layer tree.

2) Select Blend Mode and Opacity for the current level using the controls on Combine Images.

Changing the Order of Image layers in the Layer Tree

Not all blend modes are commutative so the order of image layers in the layer tree can be important.

1) Left click to select the image layer that you want to move to a different position in the layer tree. You can also left click on the open image window to set it as the current image layer in the layer tree.

2) Use the *Top, Bottom,* ↑, and ↓ buttons in the Source Image Stack Order section of Combine Images to move an image layer to a different position in the layer tree.

Changing the (x, y) Position of an Image in the Combination Image

1) Left click to select the image layer that you want to move to a different position in the combination image. You can also left click on the open image window to set it as the current image layer in the layer tree.

2) For a large shift in position left click and hold on a feature on the current image in the combination window and drag it to a new location. Use the arrows in the Source Image (X, Y) section of Combine Images to move the current layer in a precise direction and amount.

Image Layer Processing Order

The image layer tree is processed from bottom to top. The bottom layer L_1 with its blend mode, opacity, and mask is applied to a black image to create the first level combination image. *Normal blend mode with 100% opacity and no mask should be set on the bottom layer.* Next the second layer L_2 from the bottom is combined using its blend mode, opacity, and mask with the first level combination image to create the second level combination image. The combinations continue working up the layer tree from bottom to top until the top layer is combined. The final combination image displayed is the result. The combination image at a given layer level can be seen if the *Use Image* check box is unchecked for all higher layers.

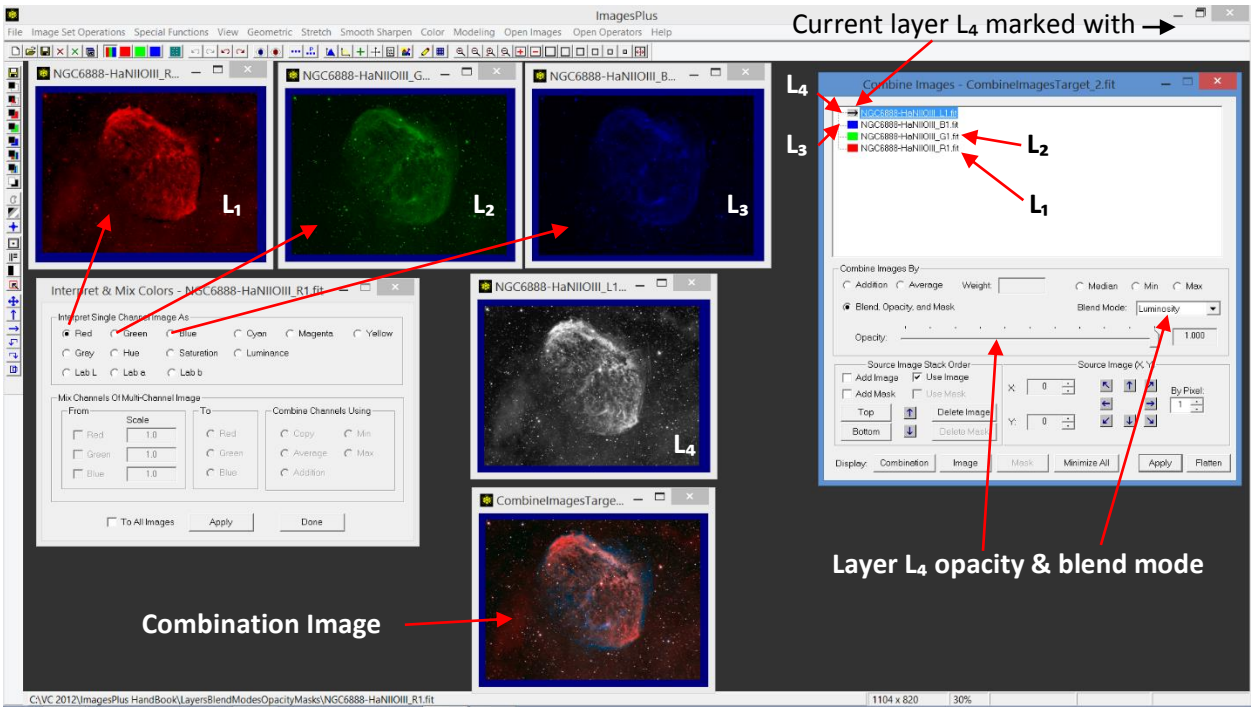


Figure 21 Combine Images can be used to perform LRGB luminance layering. First a color image is built from the red, green, and blue image layers each with Normal or Add blend mode. The luminance layer L_4 is placed above the red, green, and blue layers so that it can be used as the luminance of the color image built by the red, green, and blue color layers. The luminance layer has Luminosity set as its blend mode. The Interpret & Mix Colors tool is used to assign the monochrome red, green, and blue grayscale images to red, green, and blue for combination using Combine Images.

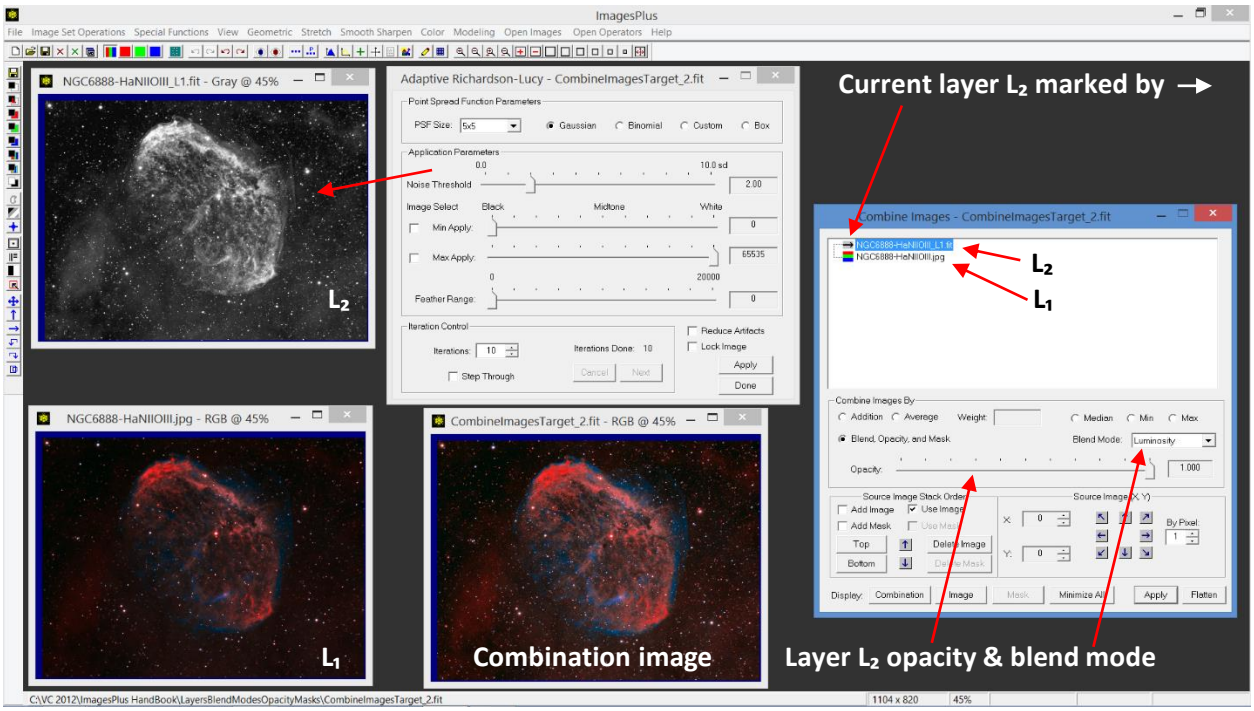


Figure 22 Luminance layer with a single color image. The bottom layer L_1 with normal blend mode is a color image from a DSLR, one shot color CCD, or assembled from red, green, and blue CCD images. The top layer L_2 is a luminance image with Luminosity blend mode set so that it brightens the color layer below. Adaptive Richardson-Lucy deconvolution has been applied to sharpen the entire luminance image before it is used as luminance for the color layer. Sharpening the dark background can create a noisy background so a mask can be used to restrict sharpening to the brighter areas of the luminance image as shown in Figure 23.

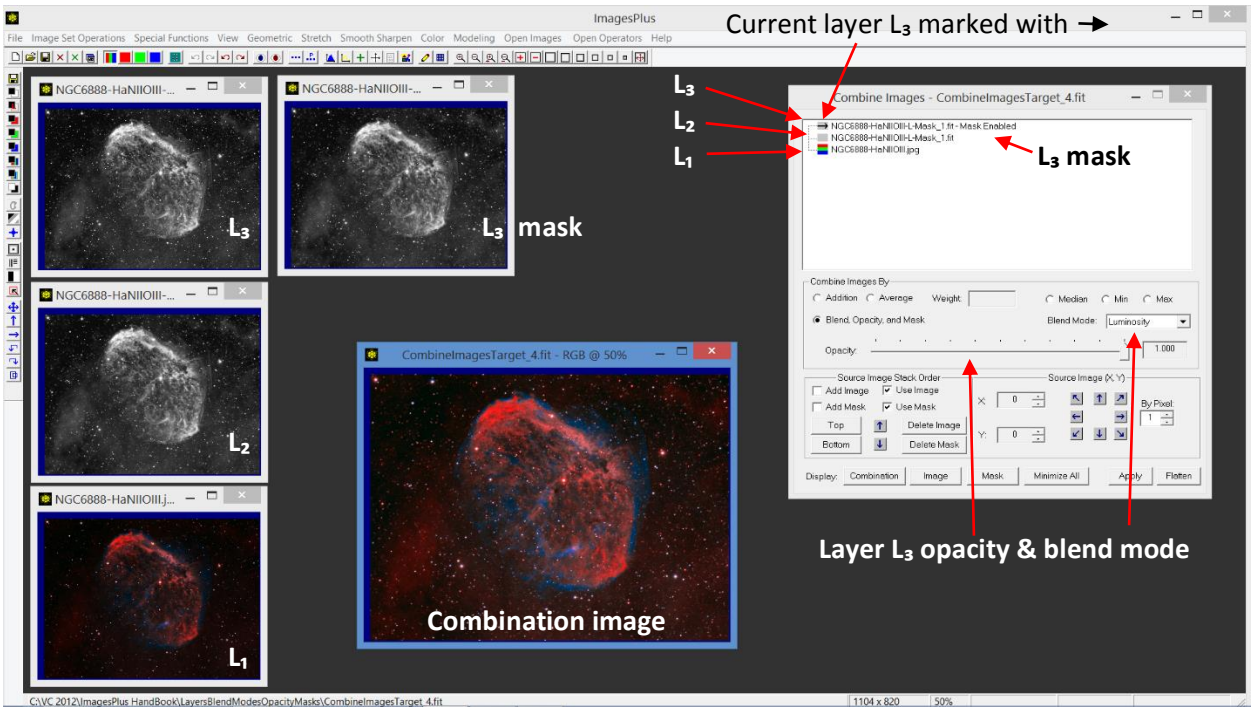


Figure 23 Luminance layer sharpened with luminance mask so that only the bright areas are sharpened in the combination color image. First layer L_2 is used a luminance for the color in layer L_1. Two duplicates of image L_2 are made and used as layer L_3 and L_3 mask. Layer L_3 is sharpened then used as the luminance layer with mask so that only the brighter areas of the luminance image are sharpened.

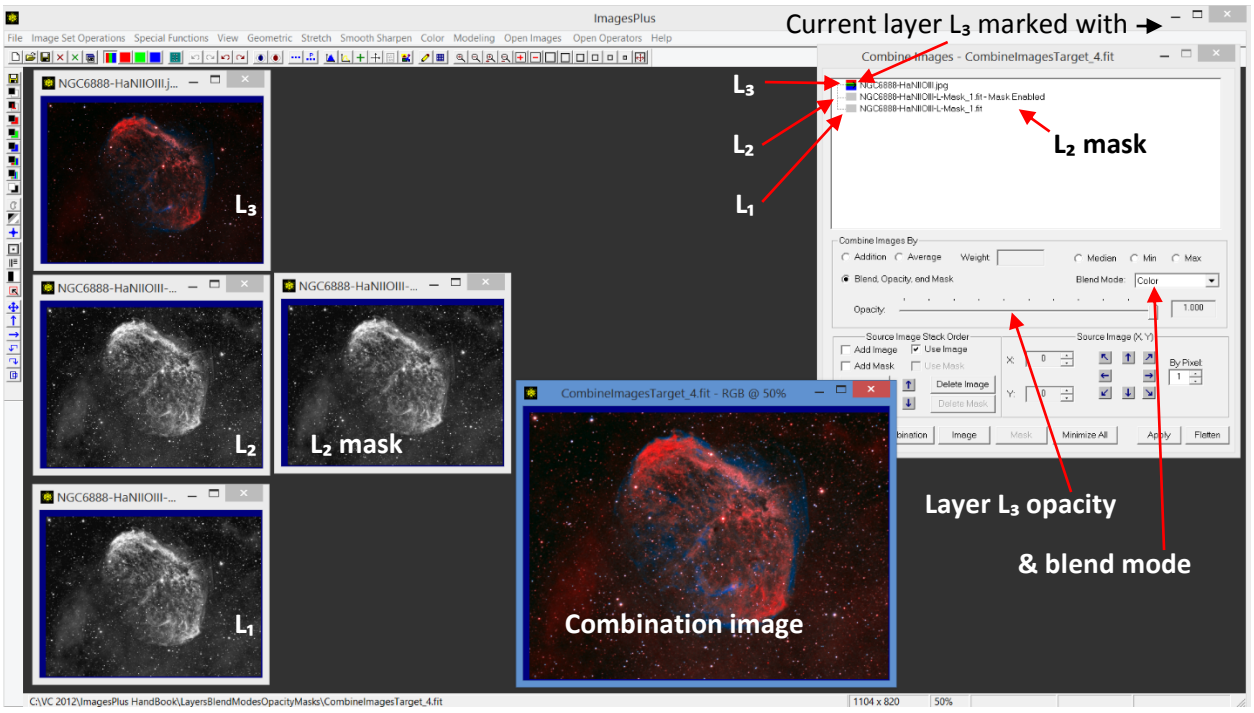


Figure 24 Same combination image as in Figure 23 but this time the color layer L_3 is placed on top of the mask sharpened luminance. Layer L_3 is assigned Color blend mode so that only the hue and saturation of layer L_3 is used with the luminance from the combination of layers L_1 and L_2.

Combine Images Summary

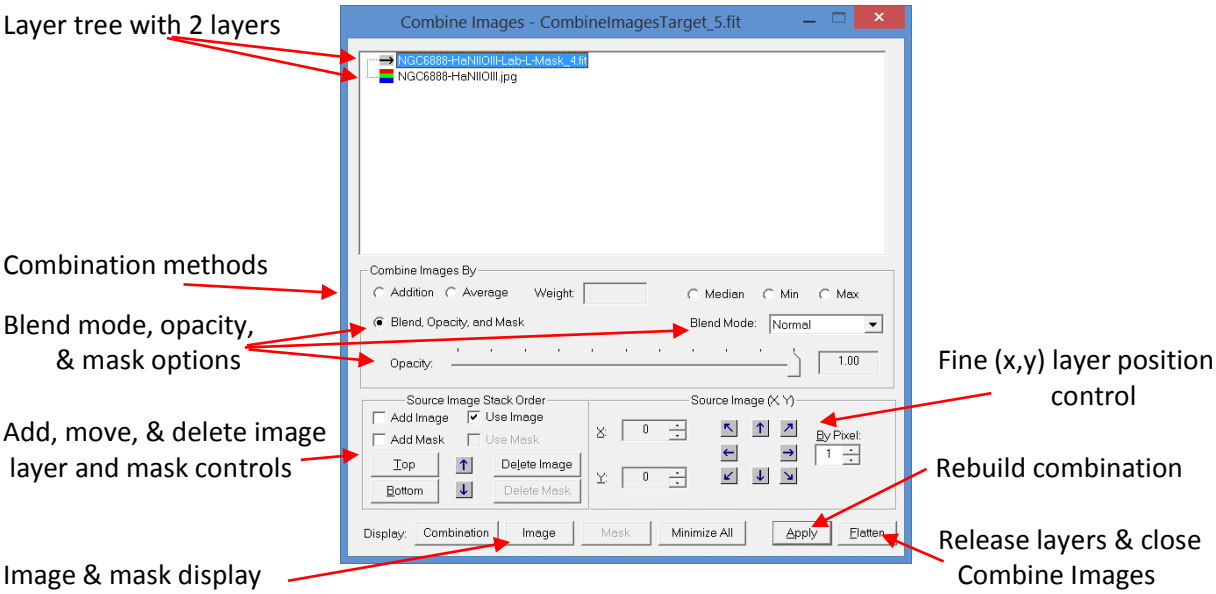


Image files used in this chapter are available at Layers, Blend Modes, Opacity, and Mask Image Files.

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