

Objectives:

There are three principle objectives for this observing session.

- a) To understand the processes of combining filtered CCD images to produce a colour image.
- b) To understand how to produce and enhance a colour CCD image using Photoshop.

Note:- This lab is written assuming that you are using my test images which have flat fields for each filter. If you are using your own images and do not have flats for each filter, you will need to modify the procedure accordingly.

Introduction:

Although Charge-coupled devices (CCDs) are now the standard tool of astronomy for recording images of the sky, all CCDs used by professional astronomers, and virtually all amateur grade CCDs and monochrome. That is, they record images in varying shades of grey. While this is fine for most scientific applications, the spectacular colours that many celestial objects display are lost. However, there are ways of using a monochrome CCD to produce a colour image. The usual way is to take individual images of an object using colour filters and then combining those images to produce a colour image.

The simplest method is to use red, green and blue filters. (RGB imaging) This method works because of the manner in which our eyes see colour. In our eyes are three types of colour receptor cells. One is sensitive to red wavelengths, one to green wavelengths and one to blue. The brain then combines these three signals to produce the complete range of colours that we see in the world around us. Your TV and computer monitor work in the same way. In this lab, you will learn various methods for combining images taken with colour filters to produce a colour image. The images you will use are of the emission nebula M17, and were taken with red, green, blue, and clear filters.

As with the previous image processing lab, make sure you make notes on each step in your processing for future reference. You will need to hand in these notes at the end of the lab, along with printouts of the final images.

Calibration and Combination of the Individual Images:

First go to <http://www.phys.ttu.edu/~rmorehe/ASTR2401.html>. Under “Classroom Labs” click on the “[Data Files for Lab Four](#).” Download the file and unzip (extract) it into the ast2401 directory. This should make a folder called colour. In this folder there are images of M17, there are also master dark and master flat images. Normally you would have flat fields for each filter, however on this night it was not possible to obtain them. **Copy** all of the images over to your own folder on the hard drive. You will then need to make several sub-folders in this folder. You will need a temporary folder, a folder for your calibrated images, a folder for your aligned images, and a folder to place the raw images once you have calibrated them.

Now you are ready to start the calibration, just as you have in previous labs. However, remember that normally each filter must be calibrated separately.

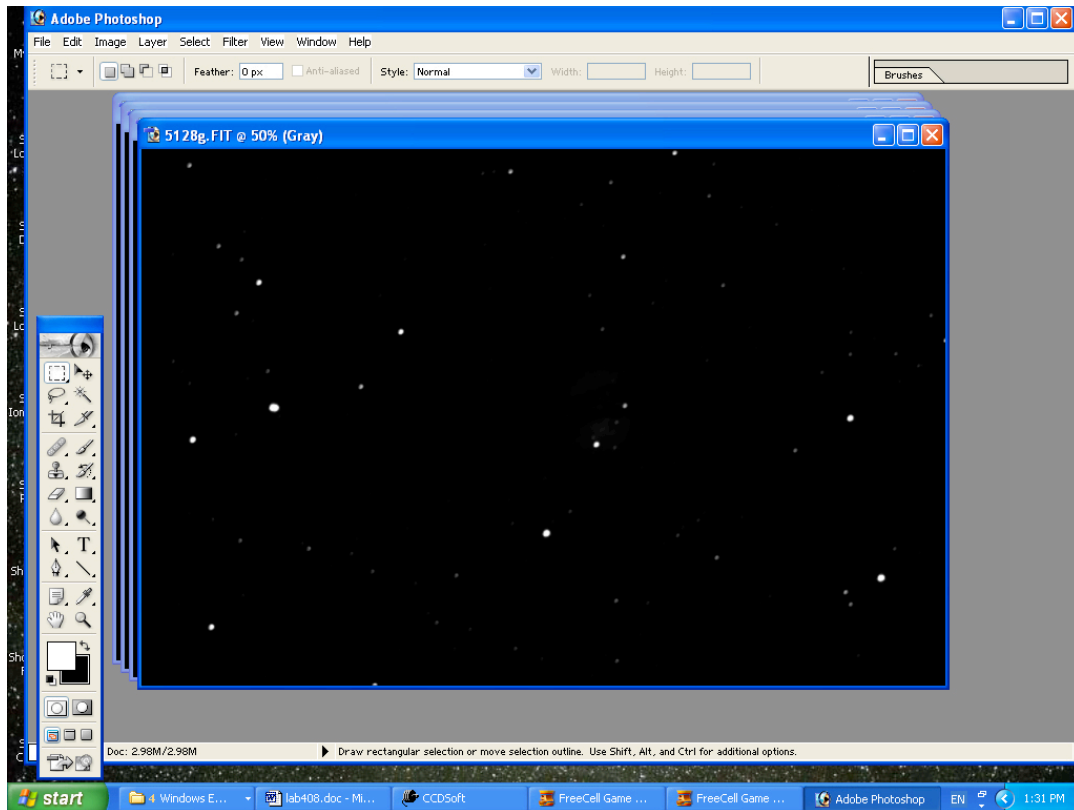
Once you have finished, move all of the raw images, including the raw darks and flats in your “raw” folder, leaving nothing in your main folder, nothing in your temporary folder, and only the calibrated object images in your “calibrated” folder. **Check that this is so!**

Now it is time to align the images. Sometimes you can align all of the images together and sometimes you have to align each filter set separately. It just depends on the images and the object. At first, try to align all of the images in your “**calibrated**” folder together as you learned to do in an earlier image processing lab, saving the aligned images in your “**aligned**” folder. Once the alignment is completed, open all of the aligned images and blink them to make sure the alignment was done correctly. If it has been done correctly, you can delete the images in the “calibrated” folder. If it is not, you will have to align each filter set separately.

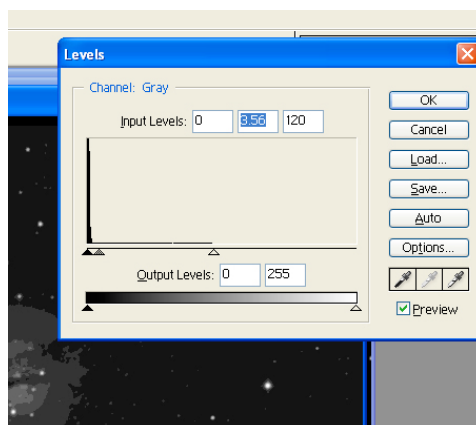
The next step is to combine each set of images. To do this, move the blue images into your temporary folder. Now combine these image using both “**add**” and “**median**”. Save these images into your main folder, making sure that the name you give it indicates that they are the blue images and that you know which is the add and which is the median! Now delete the blue images from your temporary folder, and move the **green** images there. Once again, combine these green images using both “add” and “median”, and save the resulting images in your main folder. Then do the same with your red images. With the **unfiltered** images, generally these will need to be combined using “**median**”. This is necessary, because if you use the “add” method, many of the brighter stars will saturate.

If you had to align each filter separately, you will need to align the combined images. Do this, saving the images in your “**aligned**” folder. Once these images are aligned, you are finished with CCDSoft, so close that program. However, before you start PhotoShop, make a copy of your combined images. This is important as once you open an image with Photoshop, you cannot open it again with CCDSoft. Without a copy, if anything goes wrong you would have to start at the very beginning!!!!

In Photoshop, open the four images you just made. Almost certainly you will not be able to see much in each image. They are likely to be dark. ***DON'T PANIC!*** The details are there, it is just that Photoshop does not do any automatic scaling of the images like CCDSoft does.

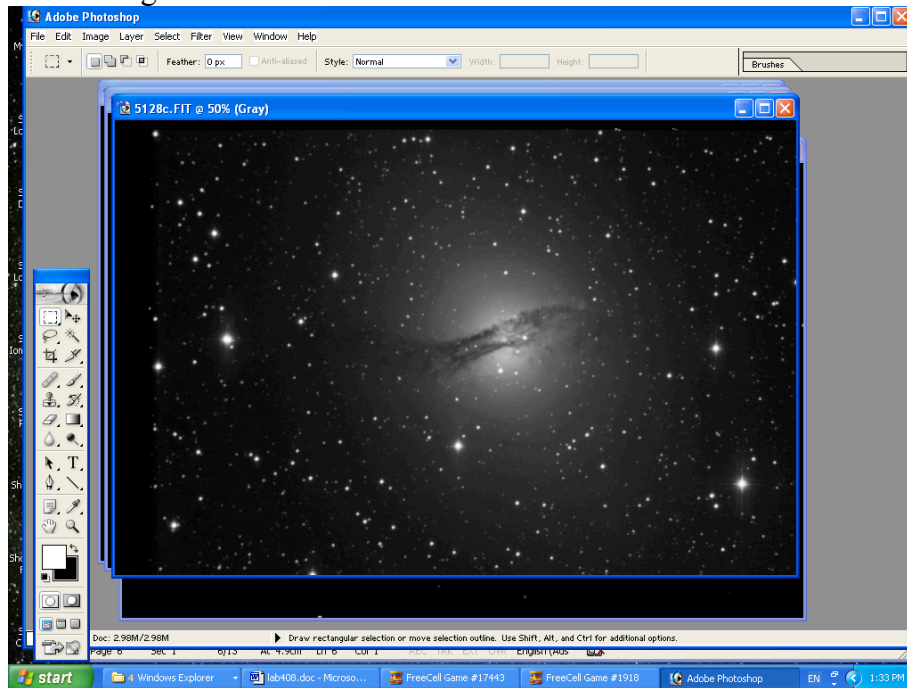


Start off with your **unfiltered** image. Use the “**Levels**” routine slide the middle triangle to the left until it reaches where the histogram begins to rise.

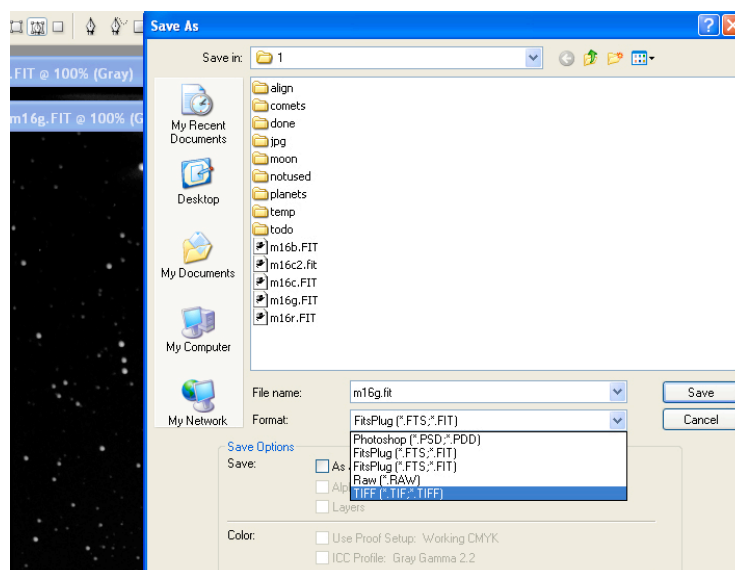


This will probably result in a “washed out” looking image, but at least you will be able to see more of the image! Use the “levels” and “Curves” routines until you get the image

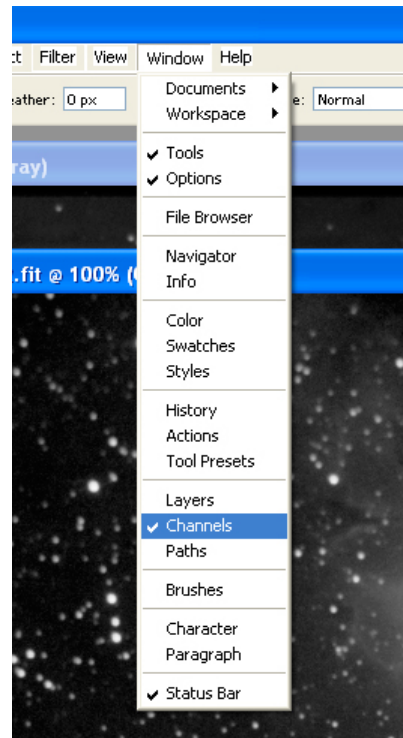
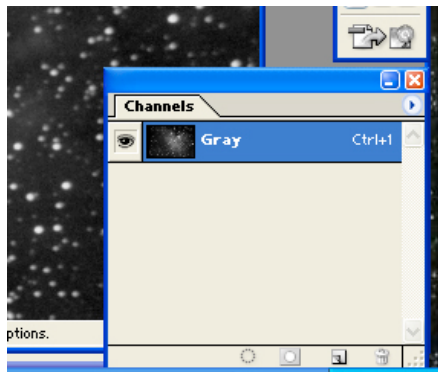
looking reasonable, **but do not overdo the brightness!** The image should remain a little dark at this stage.



Now it is time to start on your colour images. Select the **red** image to start with. As before, using the **levels** routine, slide the middle triangle to the left, to about where the histogram starts to increase. (**DO NOT use the “curves” routine**) Note the background brightness of the image. Then adjust the middle slider for **green** and **blue** images until the brightness of the background matches that of your red image. This is **very important** as if you do not do this, the colour balance will be incorrect. Do not worry if they do not look particularly good, you will fix that later. **Save each image with a different name from before so you do not overwrite your original images!** Save the images as **.tif** files.

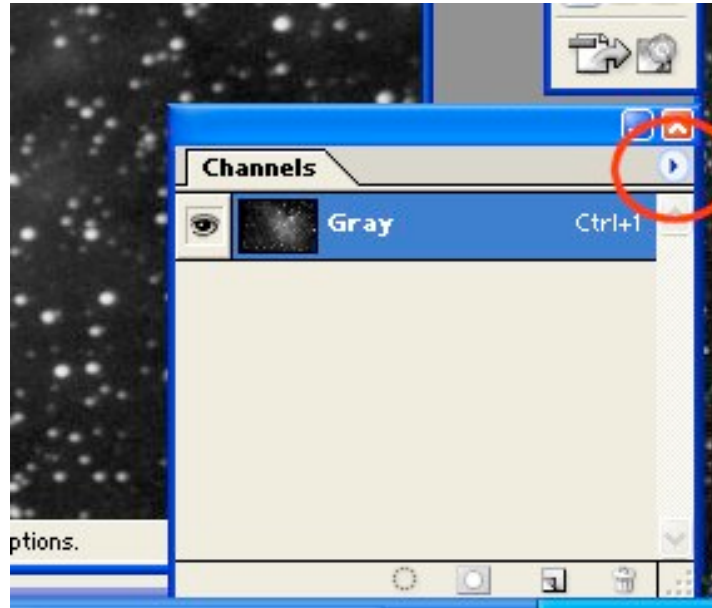


Now you are ready to combine your images to produce a ~~color~~ color image. In the bottom right-hand corner of Photoshop. Make sure you Red, Blue, and Green images are open and make sure you flatten all the layers in each image before you continue. You can do this by going to “**Layers**” and selecting “**Merge Visible**” or “**Merge Down**” there should be a window entitled “**Channels**”.

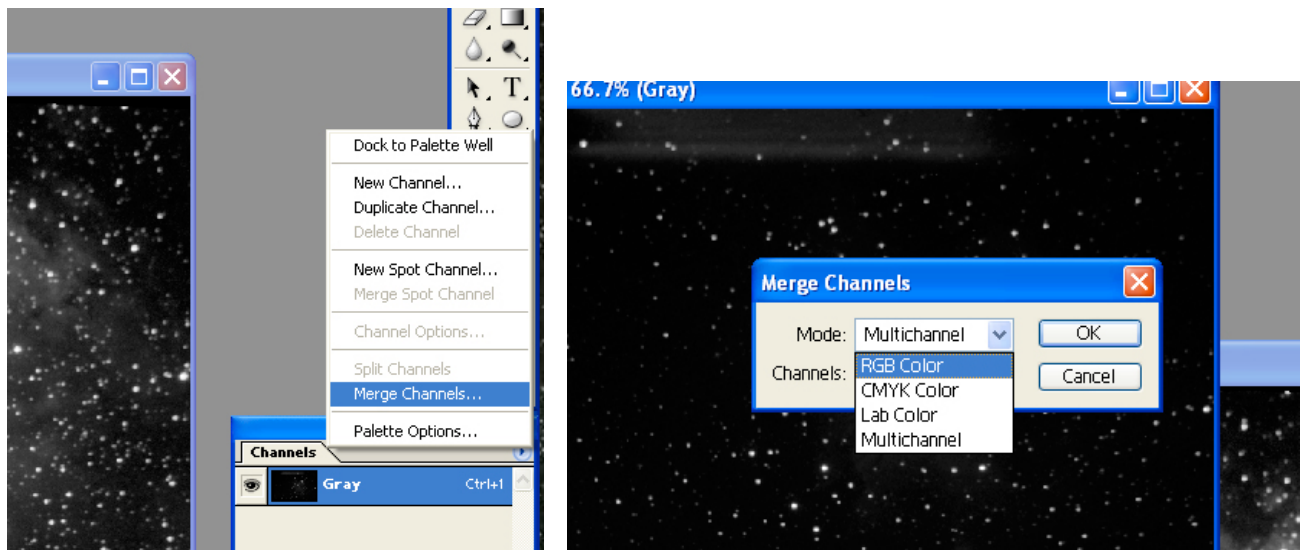


If it is not visible, go to the “**windows**” menu and from the pull-down menu select “**Channels**”.

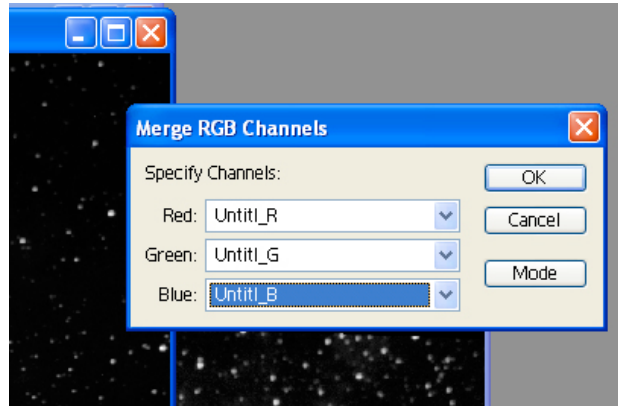
On this window, there is a small arrow. Click on this arrow and a dialog box will open.



Click on the “Merge Channels” option and then the RGB option.



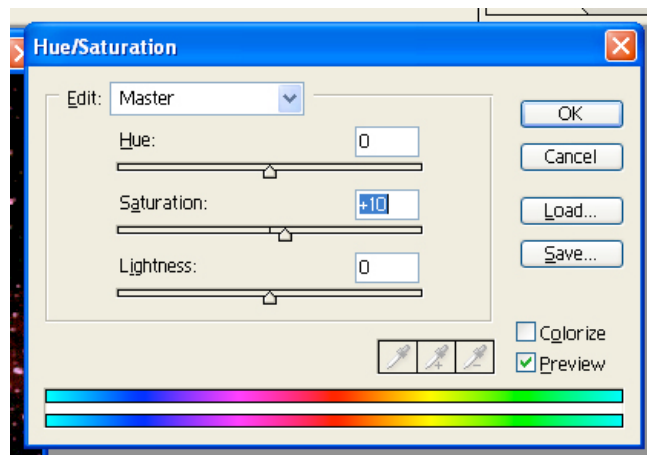
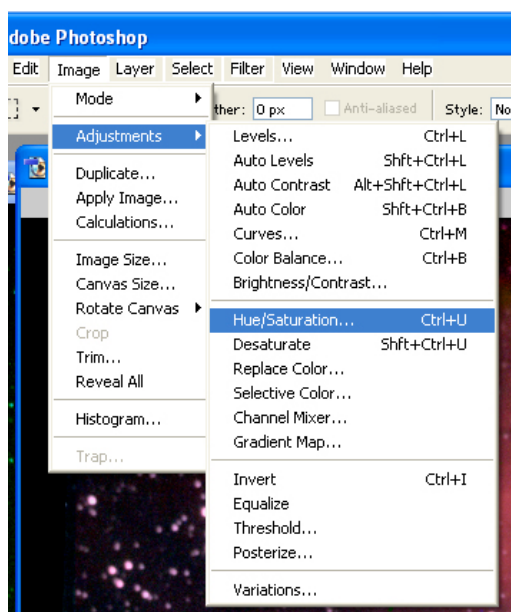
You will now be asked to specify which image should be used for which colour channel. Make sure you enter your **red** image in the **red** channel etc. For now, ignore the unfiltered image.



Once you have done this, click “OK”. Photoshop will now combine your images to make a colour image! 😊 **Save** this image as a .tif file.

Your colour image will probably look somewhat dark. To improve the appearance, use the “Curves” and “Levels” routines to brighten the image. You will notice one difference in using these routines this time however. Since you have colour images this time, each time you go to “Levels” or “Curves” you will have the option of adjusting not only the overall brightness levels, but each colour individually. This can be very useful for gaining maximum detail while still preserving the correct colour balance. Using “Levels” can be very useful for getting the right colour balance, particularly for the background. So usually I will use that at this stage to try and get the background colour to be a darkish blue/green colour. **However I almost never use “Curves” for one colour only as you must use considerable caution or you will totally destroy the colour balance and have to start over again.**

One other thing you might notice, as you make the image brighter, the colours get paler. This is a pain, but it is also normal. You have to strike a balance between brightness and colour saturation. You can improve the colour saturation by using the “saturation” command. To do this, go to the “Image” menu, choose “Adjustments” and the “Hue/Saturation”.

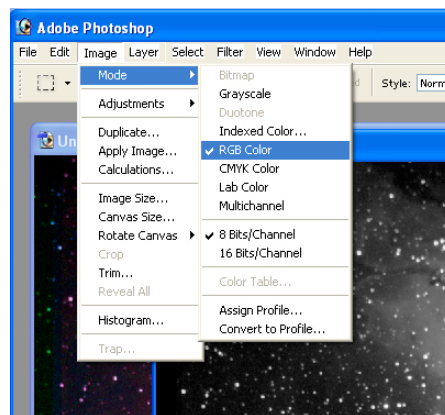


However, you should not increase the saturation too much or your image will look too artificial. I generally find that 10% - 15% is the maximum you can do without messing up the image.

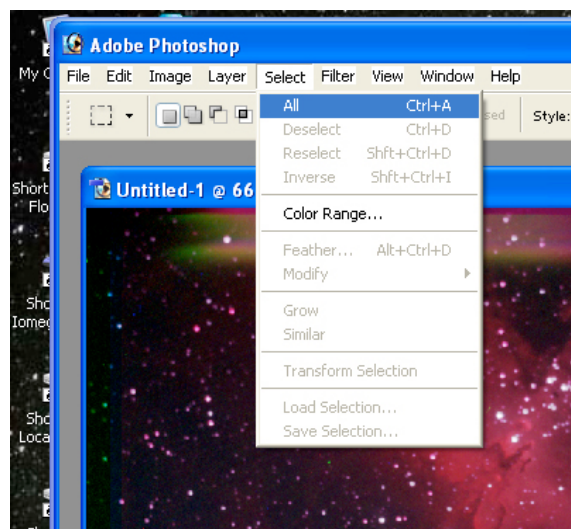
Once you have the image looking as good as you can, save it as a .tif file.

While you can get quite a good image from just the RGB images, it probably does not look the best especially if you have only a few filter images. This is why you have the unfiltered image. Our eyes are very good at picking out detail in the brightness part of the image, but poor at discerning detail from colour information. So you will use the unfiltered image to supply the brightness and detail to the image.

Click on your unfiltered image so that it is the active image. Then go to the “**Image**” menu and under “**Mode**” click on the “**RGB color**”. This will change the image mode from grayscale to colour.

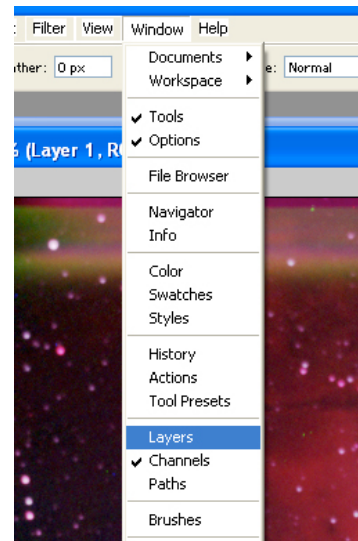
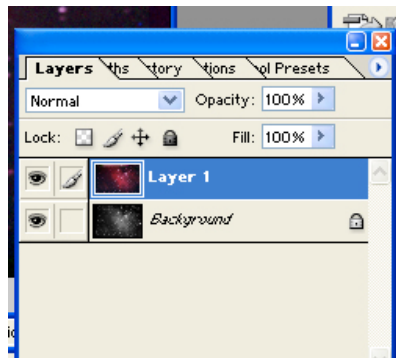


Now click on your colour image so that it is now the active image. Under the “**Select**” menu, highlight “**All**”.

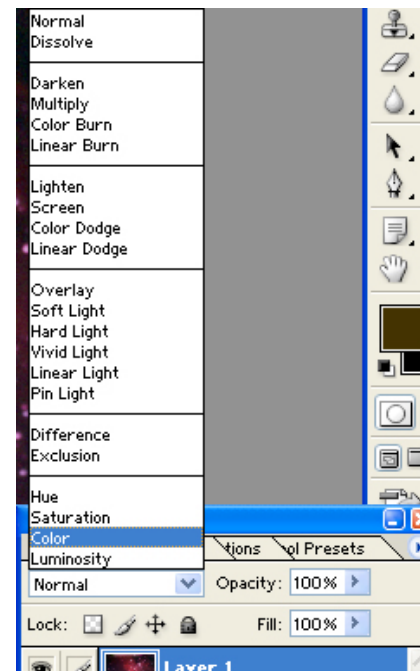
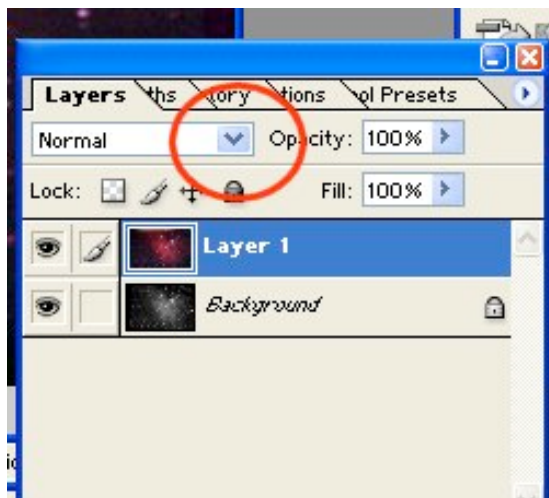


Now in the “**Edit**” menu, click on “**Copy**” to copy the colour image, and then “**Paste**” this image into your unfiltered image. Your colour image will now be sitting on top of the unfiltered image as a second layer.

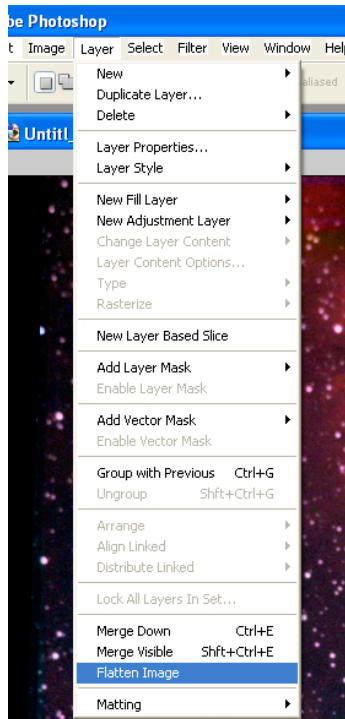
On the right of your screen in addition to the “**Channels**” window, there should also be a “**Layers**” window. If this one is not visible, go to the “**Windows**” menu and click on “**Layers**”.



In the “**Layers**” window, click on the arrow that is beside the word “**Normal**”. This will bring up a number of options for blending the two layers of your image.



Click on the option “**Color**”. Photoshop will now combine the two layers into one image. This option combines the colour information from the colour layer, with the brightness information from your unfiltered image, creating a brighter image.



As before, you may find that the brighter your image, the paler the colours appear. You can try to improve the colour saturation using “Curves” and “Layers”, **however before you do, you must “flatten” the image**. That is, combine all the layers into one. To do this, go to the “**Layer**” menu and choose “**Flatten**” from the list.

Now you can try and improve the colour saturation of your image with the “Curves” and “Levels” routines.

You can also try increasing the saturation of the entire image by using the saturation command as you did earlier. As before however, you should not increase the saturation too much or your image will look too artificial.

When you are finished, save this image on your flash drive and then hand in both of your colour images along with your processing notes.