

Color Images (version 6)

We've been working with images in "white" light. It is possible to create color images as well. The process is a little bit more complicated than just white light, where shades or gray are determined simply from the number of photons counted on each pixel. "Pretty colors" require images of your object in at least three filters (green, red, and blue). At Mt. Cuba, we use the Johnson filter system, so our typical filters are u (ultraviolet), v (visual), b (blue) and r (red). The U filter only allows ultraviolet light (around 3500 Angstroms) through, the B (blue) filter lets light around 4500 Angstroms through, the V (visible, also called green) filter lets light around 5500 Angstroms through, and the R (red) filter lets light around 6500 Angstroms through. Image file names will contain the appropriate filter letter in their names, usually as the very last letter before the extension. An image taken with no filter (usually includes "nf" in the file name) helps improve the detail in the final image. Calibrated color images also require flat fields taken in each filter. The three different images are calibrated, using the corresponding flat taken with the same filter, and then combined to create a final color image. The steps below outline the reduction process. This information is also covered in the book (Ch 21). Make sure you read the relevant pages before attempting this exercise.

- 1) **Calibrate the images for each color.** Choose an object for which we have color observations (i.e. Orion Nebula, M31, M13, or M57). You must calibrate the images for each color separately, using the appropriate flat field. You must re-initialize the calibration setup for each color and load the appropriate flat field for each image. You do not have to reload the biases or the darks. After you have loaded the appropriate calibration files in the calibration setup window, click "Multi-Image → Autoprocess Deep Sky and select the images with filters that match the flat field you are currently using. Repeat for each color. You will end up with a stacked blue image (using images taken with the b filter), a stacked green image (using images taken with the v filter), a stacked red image (using images taken with the r filter), and a stacked clear image (using images taken with nf (nofilter, if there are nf images)). Save each of these stacked images.
- 2) Open your stacked images, if they are not already open.
- 3) Use the gradient correcting and sky background corrector tools on each of your stacked images, if necessary.
- 4) **Register the Images.** You need to align the separate images so they can be combined properly. Click on Multi-Image → Register Images. The Image Registration Tool will appear. Register the red, green, and blue images using the clear image as the master. Select "1 star alignment". Once you have specified your master and slave images click "Register Images". The program will take you to the master image, with the heading "Select Alignment Stars". Click on the star you wish to use. Go back to the Register Images Tool and click Star 1. Click "Ok". The program will then ask you to select the same alignment star in each image. When you have finished, the program will shift each image a bit to place the alignment star in the same spot in each image.
- 5) Click on the Colors → **Join Colors Tool**. The menu item will open (move it to the edge of the screen so it will not obstruct your view of the image). You will see a set of four drop-down list boxes labeled Red, Green, Blue, and Luminance. Select the

appropriate box for the appropriate image. Select your stacked Red image for “Red”, your green image for “Green”, your blue image for “Blue” and the clear (no filter) image for Luminance .

- 6) **Create a color image.** AIP4WIN can automatically balance your color images. Create a color image using the color channels you selected by selecting the “Automatic Color” radio button and then clicking the “Make Color Image” button. A color image is created. Describe how your image looks. Is it too dark? Do the colors look realistic?
- 7) Now it is time to play a little. Go back to the Join Colors Tool. We will explore some of the neat things you can do when creating your color images. Start by selecting your red, green, blue, and luminance images.
- 8) Adjusting the Brightness. This is useful if your image is too dark. Select the “Automatic” tab in the Join Colors Tool and set the Automatic Luminance to 0.992 and the Histogram HiPoint to 0.998, and click the Make Color Image button. The resulting image should look brighter. Is this true?
- 9) Click on the “Adjusters” tab. Slide the Gamma slider to a value of 1.7 and click the Make Color Image button. Faint detail should be more prominent. Is this true? Experiment on your own, and record the values you find for your image.
- 10) Cleaning Up Color Artifacts. AIP4WIN provides useful tools for controlling artifacts due to such things as chromatic aberration and saturation. Open the **Color Effects Tool** (you must have created a color image to be able to open the tool). Click “Apply Color Effect”. What changes in the image?
 - a. What is chromatic aberration?
 - b. What is saturation?
 - c. Experiment with input values for the Rolloffs and Cutoffs. Can you make the saturated stars look “unsaturated”?
- 11) Crop the Color Image. Often there is an area around the edge of the image where the individual color images did not overlap when they were registered. You can crop the edges off by clicking Transform → Crop. The Crop Tool window will appear. Use the mouse to select the region you wish to keep and click the Apply button. A new image will be created from the selected region.
- 12) To make accurate color images, the signal in each separate image must be proportional only to the flux from the celestial object in each filter (also called bandpass). A reliable way to do this is to obtain filter images of a standard object of known color. In astronomical imaging, we use main sequence stars like our sun (classified as spectral type G2V) as standards. Go to the Join Colors Tool and try experimenting with the G2V tool.
- 13) Try experimenting with the manual settings in the Join Colors Tool. What happens if you set the various Sky colors to a high value (lets say 1000). What happens if you set the values to 100? What happens when you double the various Bright settings? What happens when you set them to 0.05?
- 14) Save the image. When you are satisfied with your results, the color image you created can be saved in many different formats. Click File → Export, and a box will appear to prompt you for the file name and location. You can select the format you want to save your file in. Many programs do not recognize FITS format, so JPG or TIF are popular. If you want to preserve the greatest flexibility for future editing of

your image, you should save it as a 32-bit floating point FITS file. This format preserves the full dynamic range of your data along with all the color detail.

- 15) Later Adjustment of the Color Image. You can work with the image later by clicking the Color→**Color Image Tool**. This is intended to work on images where the color files have already been joined. Select the Adjusters tab. Slide the Color Saturation to a value of 0.91 and click the “Make New Color Image” button. Experiment with the various possibilities. What happens when you turn the Color Saturation control all the way down to 0 and create a new image?
- 16) Stars vary their light output at different wavelengths. Reload your stacked images for each color. Start with the clear image. Select 10 stars from the image. Don't chose just the bright stars. Mix in some fainter ones. Click Measure→Photometry→Single Star. The single star photometry tool will appear. Click on your first star. Information about your star will appear in the Tool box. Record the x and y coordinates, and the Star-Sky value (in ADUs). Repeat for your other nine stars, and then repeat for each image. You should end up with a table something like the following:

Star	X coord	Y coord	Blue	Green	Red	Clear	
1	145	150	30000	40000	60000	100000	
2	300	200	10000	30000	20000	30000	
3	550	400	5000	2000	1000	3000	

- 16) Create a graph using (Blue-Green) for the x axis, and (Green-Red) for the Y axis. What do you find? Consult with other members of the class and create a graph using everybody's stars.