Name: Date:

Making a 3-color Image with MicroObservatory

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Objectives

- List the three primary colors of light
- Describe how film and digital color images are produced
- Produce a three-color (RGB) image using MicroObservatory

Materials

Computer with Internet access
MicroObservatoryImage software available for download at
http://mo-www.cfa.harvard.edu/OWN/software.html)

Cross-Discipline Extension Activities

Below are links to various cross-discipline activities that are extensions of this topic.

Biology
PhET Simulation—Color Vision: http://phet.colorado.edu/en/simulation/color-vision
Chemistry
Color and Dye Chemistry: http://www.dharmatrading.com/home/color-and-dye-chemistry.html Chromatography: http://www.terrificscience.org/freebies/lessonexchange/chroma-electro/
Physics/Physical Science
Color Addition: http://www.arborsci.com/ArborLabs/PDF_Files/ASLab_8.pdf
Earth/Geology/Environmental Science
Adventures in Fiber Optics (with Ulexite): http://www.arborsci.com/Data_Sheets/Adventures_FO.pdf
Math
Investigating Opacity and Extinction: http://spacemath.gsfc.nasa.gov/weekly/10Page106.pdf
Engineering
Index of Refraction—Materials Science: http://www.arborsci.com/cool/index-of-refraction

Additional Information

For additional information on how digital cameras work, please visit the following site at the American Chemical Society for an article on, "The Chemistry of Digital Photography and Printing:"
http://www.acs.org/content/dam/acsorg/education/resources/highschool/chemmatters/archive/february-2006.pdf.

Introduction

MicroObservatory (MO) is a free on-line telescope where you can select an astronomical object from a menu. It also allows you to select the exposure time, field of view, and filter (where applicable). MO will help guide you through the process of selecting the right parameters. You do not get to "drive the telescope," or see the image being taken in real time as with SLOOH. Everyone that requests an object gets the same image sent to his or her inbox.

Requesting an Image:

Go to http://mo-www.harvard.edu/OWN/training.html and click "How to request an image" to watch a short, 1-minute video that will explain how to use the MO. Following those instructions, choose your target and request your images.

It is highly recommended you do this at least four days in advance. Typically, the images are e-mailed to you the next day. However, technical issues with the telescopes and weather-related issues may arise. There is also an archive data link where you can download images (just read the image info to make sure you have a red, green, and blue image). The link is: http://mo-www.harvard.edu/jsp/servlet/MO.ID.ImageDirectory.

Following those instructions, choose your target and request your images.

1. From the training page, click "Control Telescope."
2. You will see a list of targets. Any object that is greyed out is not visible in the sky tonight. Choose one from the list in the table below, and click, "Observe."
3. Select your Field of View (if it is an option).
4. Select your Exposure Time (the website may suggest that your selection might result in an under- or over-exposed image…select accordingly).
5. Select "Multiple Filters." You want all three filters (red, green, and blue) so that you get three images that can be combined into a color image. If multiple filters aren't an option, choose a different image. You need to have all three filters to make an RGB image.
6. Click "Continue."
7. Enter your e-mail address (your images will be e-mailed to you as soon as they are ready). Fill out the rest of the information if you wish, and click, "Submit."
8. A confirmation window will appear.

When Your Images Arrive:

Go to the link in your email and download your three images in FITS format (this is the standard format used by astronomers). Be sure to name the files clearly, so that you know which image was taken through which filter (e.g. "orionRed.FITS" for an image of the Orion Nebula with a red filter). The filter color is listed in the Image Info file.

Activity

1. **Open your three images:** Launch the MOImage processing program on your computer. Open the image taken through the red- passing filter. Do the same for the images taken through the green- and blue-passing filters. You should have three images open.

2. **Adjust brightness and contrast:** Under the **Process** menu, select **Adjust Image.** When the Adjust Image window opens, select the **Log** button, and then click the **Auto** button to get a good first look at the image. Then go back to the **Process** menu and select **Reduce Noise**. Do the same for the other two images: Hit the auto button to automatically adjust brightness and contrast.

3. **Color each image red, green or blue:** Work with the red-filtered image first. Under the **Process** menu, select **Color Tables→ Red.** Your image will turn red. Then work with the green-filtered image, selecting **Color Tables→ Green** under the **Process** menu to turn the image green. Finally, color the blue-filtered image blue by selecting **Process →Color Tables →Blue.**

What's going on? The areas in the original scene that had a lot of red became the brightest areas in the red-filtered image. In turn, these bright areas in the red-filtered image will become the reddest areas in the final image. The same holds for the green- and blue-filtered images.

4. **Stack the images.** Under the **Process** menu, select **Stack → Convert Images to Stack.** You can flip through these images if you like, to see them individually.

5. **Align the images:** Your three images will probably be out of alignment. You'll need to align, or "shift" the images so that when you combine them the result won't be blurred. Under the **Process** menu, select **Shift**. As prompted, select the green image (it's easiest to see) as the **background** image over which you'll shift (i.e. align) the other two images. Then in the **Foreground** dropdown menu, select either the red or blue image to shift. (You should see the background image through the slightly transparent foreground image.) Find patterns to match up (use groupings of bright stars that are easy to see, for example). Using the **mouse keys** and the **i,j,k,l** keys as prompted, align the two images and then hit the Okay button. Align the third image in the same way and hit **Okay**.

6. Create the final color image. Under the Process menu, select **Stack→Convert Stack to RGB.** The program now merges the three red, green, and blue images to create the final image. Congratulations!

7. **Save the final image**. Go to **File →Save As...** and choose **Save as GIF.** Make sure you save your final image and label the filename clearly with .GIF as the file extension.