Lab 03 – Astronomy images Name:_______________________________

In this lab, we are going to practice making color images from black & white FITS files!

Part I – Set up

1. Download and install the ds9 program by following the specific instructions for your operating system. https://sites.google.com/cfa.harvard.edu/saoimageds9/download

2. Open ds9 and investigate at the different menu options. Note that there are drop-down menus at the top of the screen, and separate button menus in the middle of the application window. We will mostly be using the button menus, but many functions can be accessed both ways.

Part II – M16 Pillars of Creation

3. Let's open the blue image first.

    a. Open the image in DS9 with "file → open" buttons.

    b. Go to the Lab03 folder and select the "M16_blue.fits" image
    At first, it might just look like a black image, but don't worry!

4. Zoom out to see the whole image using "zoom → zoom fit" buttons.

5. Now you just need to change the scaling of the image. This setting determines how to scale the brightness values within the image.

    a. Click the "Scale" button , then choose "zscale" to start.

    b. Then play around with the other scale options. What happens if you use "linear" vs. "log"? or "minmax" vs. "zscale"? How does the image change?

    Which setting combination produces the nicest looking picture?

6. Let's find out some information about this image. Go to "file → header" to open the header for this image, which lists useful information about how this image was taken. Each keyword (written in blue) has a corresponding value (in quotes) and a comment about what that keyword means (after the "/").

    a. What telescope and instrument took this image?

    b. On what date was this image taken?

    c. How long was the exposure duration in seconds? What is this in hours?

    d. At what wavelength was this image taken? Look for the filter name, which includes the wavelength in nanometers. (For example, "F100N" would be a 100 nm filter.)

    e. What are the RA and DEC coordinates of this target? They are listed in degrees in the header, but you should convert these units to "hr min sec" for RA and "deg arcmin arcsec" for Dec.

    f. Is this nebula in the Northern or Southern hemisphere on the sky?

7. Find the bright star in the upper left part of the image (to the left of the first pillar). Hover your mouse over the center of the star, and try to find the place where you get the highest brightness listed as “Value”. This corresponds to the center of the star in the image. What is the value for the max brightness of this star in the blue picture?

8. Let’s look at the red picture now.

   a. Open a new frame (like a new tab), using “frame → new”. Then open the red image with “file → open”.

   b. You can see both images using “frame → tile” or hit the “prev”/”next” buttons to switch frames.

   c. Change the zoom and scale parameters of the red image to match the blue one.

   d. At what wavelength was this image taken (in nm)?

   e. What is the value for the max brightness of the star (from Step 7) in the red image?

   f. Is this star brighter in the blue or red image? What can we infer about this star’s temperature and appearance to our eyes?

<u>Part III – Making a color image</u>

9. To make an RGB image, make a new, special frame by choosing “frame → rgb”. A little window will pop up. DO NOT CLOSE IT! You will have to start over if you want to make any changes. Move this window off to the side.

10. We have “red” selected at the moment, so we want to open the file that corresponds with our red filter. Go to “file → open” and select the red file again. It should now appear red in your RGB frame! Change the scale to the best setting from Step 5.

11. In the little pop-up window, choose “green” and open the green image. Change the scale to the best setting from Step 5.

12. Then choose “blue” and open the blue image, and change the scale setting.

13. Your RGB image might look cool already, but we want to refine the colors a bit more. Go to “colors → colormap parameters” (at the bottom of the drop-down menu). A new window with sliding bars opens.

    a. Write down the default values, in case you need to reset them:

       contrast = _____________ bias = _______________

    b. What happens when you change the contrast?

       What happens when you change the bias?

14. You can also fine tune the scaling. Go to “scale → scale parameters” and a new window will pop up.

    a. Write down the default values, in case you need to reset them:

       low = _____________ high = _______________

b. What happens when you double the high value? Triple it?

15. Play around with these settings for each filter, and fine tune the color image until it looks more realistic. When you're happy with your image, save it with "File (dropdown menu) → Save Image → PNG". Change the file name to "Lab03_M16.png".

** If you have < 15 minutes left, skip to Part V on the next page! **
** If you have more time leftover, try making an image of a galaxy in Part IV. **

Part IV – M51 Whirlpool Galaxy

Let's look at another image! This one is a spiral galaxy.

16. Open a new frame with the blue image "M51_blue.fits".

    a. What telescope and instrument took this image?

    b. On what date was this image taken?

    c. What are the RA and DEC coordinates for this galaxy? Report your answer in "hr min sec" and "deg arcmin arcsec".

17. Repeat Steps 9-14 to make a color image of M51. When you're happy with your image, save it as a PNG with the name "Lab03_M51.png".

Part V – Reflection questions:

- How would these images be different if they were taken with a smaller telescope on the ground?

- How would the process of making a color image be the same if you had images taken at ultraviolet, xray, and gamma ray wavelengths instead? How would the process be different?

Final steps:

- Upload your color image(s) to your Lab google drive folder.
- Turn in your worksheet!