

False Color Images - a js9 activity

Purpose: To use the tools in js9 to examine features of a supernova remnant.

Background:

This activity builds on tools and techniques learned in

- De-Coding Starlight: From Pixels to Images (Introduction to Imaging)
- 3-Color Composite Images
- X-Ray Spectroscopy of Supernova Remnants
- Star Formation and U/H LX's in the Cartwheel Galaxy
- Analysis of Two Pulsating X-ray Sources

The above activities should be done first. Also, read about false color images at

https://chandra.si.edu/photo/false_color.html

To save your images, go to **File>Save>JPEG** or **PNG**. You may also take a screenshot. Images can then be pasted into a Google doc or any other kind of document or presentation.

Procedure (Using colormaps, contrast, bias, and scale):

1. Go to <https://nso.js9.org>.
2. The default image of Cas A (a type 2 supernova) is made up of pixels, each one with a number of X-rays that were recorded to hit each pixel during a given observation. Use **Zoom** until you can see individual pixels. Move your mouse over the pictures and look at the first green number in the top left which corresponds to pixel intensity. You can also go to **View>Pixel Table**. This looks much like the grid we used in "*Decoding Starlight*" to make an image of Cas A. Try various colormaps under **Color**. Compare the pixel numbers to the numbers on the color bar under the image.
3. Go back to **Zoom>Zoom 1/2** to see the whole image.
4. **Contrast** refers to the rate of change of color with color level. Contrast is adjusted by dragging the left mouse button or two fingers on a touch screen vertically in the display window. Try this and watch the color bar.
5. **Bias** refers to any offset added to the color levels before the color map is applied. In other words, it determines where the color changes start. Bias is adjusted by dragging the left mouse button or two fingers on a touch screen horizontally in the display window. Try this and watch the color bar.
6. Go to **Color>reset contrast/bias**. Notice that you can also change contrast and bias here by entering numbers.

7. Use contrast and bias and different scales (**Scale>linear**, **Scale>log** etc.) to highlight various features of Cas A such as the inner and outer shock wave and the central neutron star if it is present. Save your images.

Procedure (3 color composites using IR, optical and X-ray data):

In “3-Color Composite Images”, you made a 3 color composite image of Cas A, using red, green, and blue to show low, medium, and high-energy X-rays. Now we are going to make a 3 color composite with data from different parts of the electromagnetic spectrum.

8. In “*Star Formation and U/HLX’s in the Cartwheel Galaxy*,” you learned how to load an X-ray image using the ObsID. Load the x-ray image for the Cartwheel Galaxy (ObsID 2019).
9. Using the techniques from “*Star Formation and U/HLX’s in the Cartwheel Galaxy*,” load the optical image from **View>Archives & Catalogs** “Image Servers, DSS1@SAO, DSS1” and the infrared image from “Image Servers, DSS1@ESO, ESO DSS2 IR.”

Note: Under **File**, you will see the names of all 3 files at the top. The sun will be next to the one currently displayed. Click on the one you wish to work with.

10. Rescale the optical and infrared images so they are the same size as the x-ray image using the techniques from “*Star Formation and U/HLX’s in the Cartwheel Galaxy*” (**WCS>wcs reproject**).
11. Using the techniques from “3-Color Composite Images”, assign a red, green and blue color map to the infrared, optical and x-ray images respectively and go to **Color>rgb mode**.
12. You can manipulate the contrast and bias of each image separately or use different scales for each until you are satisfied with your 3 color composite. To see the individual red, blue or green colormapped image, toggle off **rgb mode**. If you wish to restore the original contrast/bias for any of the colormaps, go to **Color>reset contrast/bias**. Save your final image.

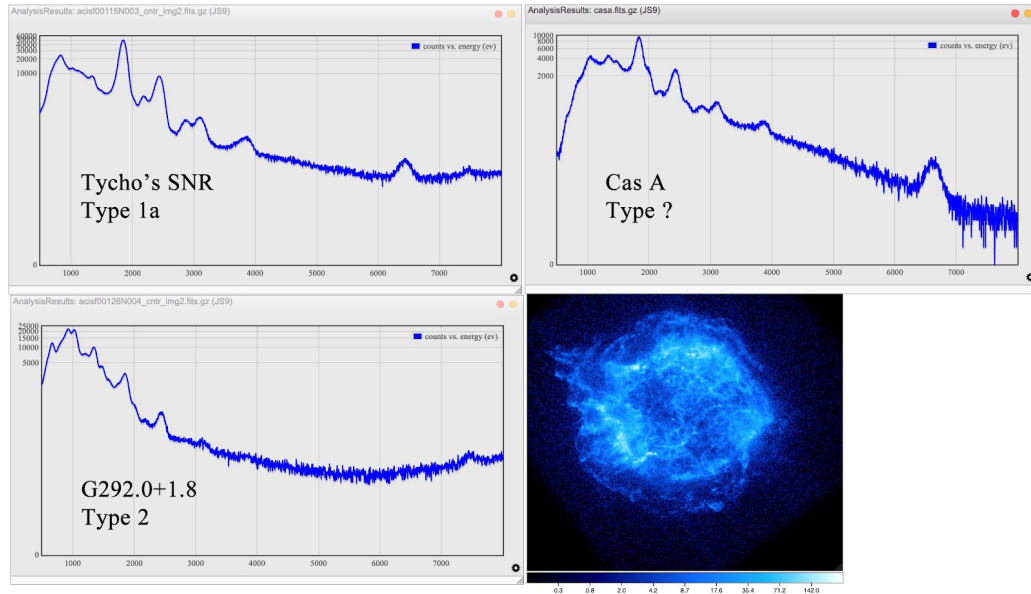
Procedure (showing element distribution):

13. In “3-Color Composite Images,” you used an event filter to display pixels in a given energy range. You can use this to show the distribution of elements in a SNR.
14. Go to <https://nso.js9.org/> and refresh the page to load the default image of Cas A. Choose **Zoom>Zoom 1/2**.
15. Create a region around the little jet in the upper left (at about 10 o’clock). Do an energy spectrum to determine what element makes up the majority of this jet. Use the table in “*X-Ray Spectroscopy of Supernova Remnants*.” Use the event filter (**Analysis>Event Filter**) to show only the photons with energies in a narrow range around this element. For example, one of the ionization states of silicon produces a spectral line of 1870 eV so you could do a range from 1860 to 1880 eV. Use a screenshot to save your energy spectrum and your final image.
16. Watch this! <https://youtu.be/VbL27QdyBvY>
17. Do an energy spectrum of the complete SNR and use the event filter to show the distribution of another element in Cas A. Use a screenshot to save your energy spectrum and your final image.

Questions:

1. On what information are the colors based in a js9 image when you initially load a FITS file?
2. What happens on the color bar when you change the contrast?
3. What happens on the color bar when you change the bias?
4. What are two different ways you can make a 3 color composite?

5. Read https://chandra.si.edu/xray_sources/supernovas.html. Examine the energy spectra below. The two on the left are the ones you produced in “*X-Ray Spectroscopy of Supernova Remnants*” with a log scale on the y-axis. We used the relative abundances of certain elements to help determine if the SNR is a type 1a or a type 2. Which type does Cas A seem to be? Explain.



6. Remember, that sometimes, due to interstellar absorption, emission lines less than 1.5 KeV are not seen. Also remember that in a Type 1a, the white dwarf is destroyed and there will be no neutron star or black hole as in a Type 2. Does Cas A appear to have a neutron star remaining? Explain. Why should you use multiple pieces of evidence in classifying a SNR?
7. Read <https://chandra.si.edu/photo/2004/casa/>. How does the information you got from steps 13-15 compare to these results?