Name:

Cosmic Photoshoot to ImPress

During this activity, you will use some of the same tools used by professional astronomers. Be sure to raise your hand whenever you need help or have a question - we are here to help!

Create your own "Cosmic Photo"

> *Stars are born in thick clouds of gas and dust. In this activity, you will use images from the Hubble Space Telescope. The example shown here is of the Eagle Nebula, also known as the Pillars of Creation, one such active stellar nursery. Using archival data, you will make your own color images using the same software as professional astronomers.*

STEP 1: Access the Data. Click on the **Eureka/** folder on your desktop, then the **EXAMPLE/** folder. These are *Hubble Space Telescope* archive images[1].

Inside are two folders: **Optical** (filters **F502N**, **F657N**, and **F673N**) and **Infrared** (filters **F110W** and **F160W**) — all taken with Wide Field Camera 3 (WFC3), installed on *Hubble* since the 2009 servicing mission.

The files are in FITS format ("Flexible Image Transport System"), the standard format for astronomical images.

The number in each filter name is the wavelength of light it lets through. Narrow-band filters ("N") pass a thin slice of light — F502N at 502 nm, F657N at 657 nm, F673N at 673 nm. Wide-band filters ("W") pass a broader range, centered around 1100 nm (F110W) and 1600 nm (F160W). See Figure 1:

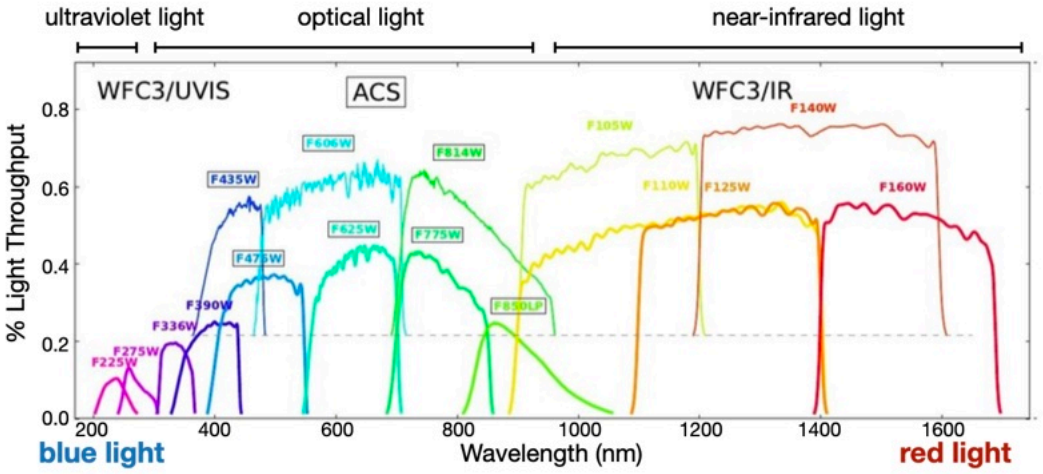
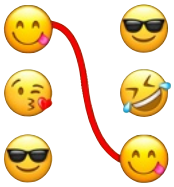


Figure 1 – *Filter transmission curves for different Hubble Space Telescope broadband filters*.

[1] `https://archive.stsci.edu/prepds/heritage/`

[1] Question: Which filter produces the red image? The green image? The blue image? Draw a line connecting each filter to the color it produces below. *(Hint: longer wavelength = redder filter. The number in a filter's name is its wavelength in nanometers — don't assume they're in wavelength order!)*

Red Image	*F657N*
Green Image	*F502N*
Blue Image	*F673N*



STEP 2: Open SAOImageDS9.

Launch SAOImageDS9, the program astronomers use to view and process astronomical images. Click the Spotlight icon (top right) and **type "DS9" into the search bar**.

STEP 3: Make your own GREYSCALE image.

In Ds9, select **file→open**. Go to **~/Desktop/Eureka** and find your object's folder. Select one image to open.

But wait — **why does the image look BLANK?** Don't worry, it just means the default scaling is bad for this image. Fix it with **scale→zscale** to start. You may also need to zoom out (**zoom→zoom out**) until the whole image fits the frame.

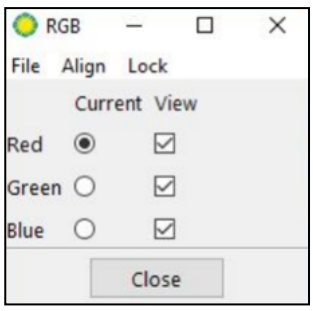
RESCALE: Figure 2 shows two ways to scale an image: **linear** (left, the default) and **log** (right). A log scaling suppresses bright features like stars and boosts faint features like nebulosity — useful when the "faint stuff" needs a boost, but it also lowers the image's contrast. Try out the different scale options yourself.

LOAD MORE FILTERS. Go to **frame→new**, then **file→open** to load the next image. You may need to redo the scaling and zoom.

***PRO TIP*:** *Use Tab to switch between frames—hold it down to cycle through quickly. Check that the stars and objects line up across frames. If they don't, select* **frame→match→frame→WCS.**

STEP 4: Everything is better in COLOR.

Combine your individual images into one color image using an "RGB" (Red Green Blue) frame. Go to **frame→rgb**. A small control window will pop up (pictured right). **DO NOT CLOSE IT, or you'll have to start over!**



Select file for your reddest filter (see your answer to Q1). In the RGB window, go to **file→open** and select that image.

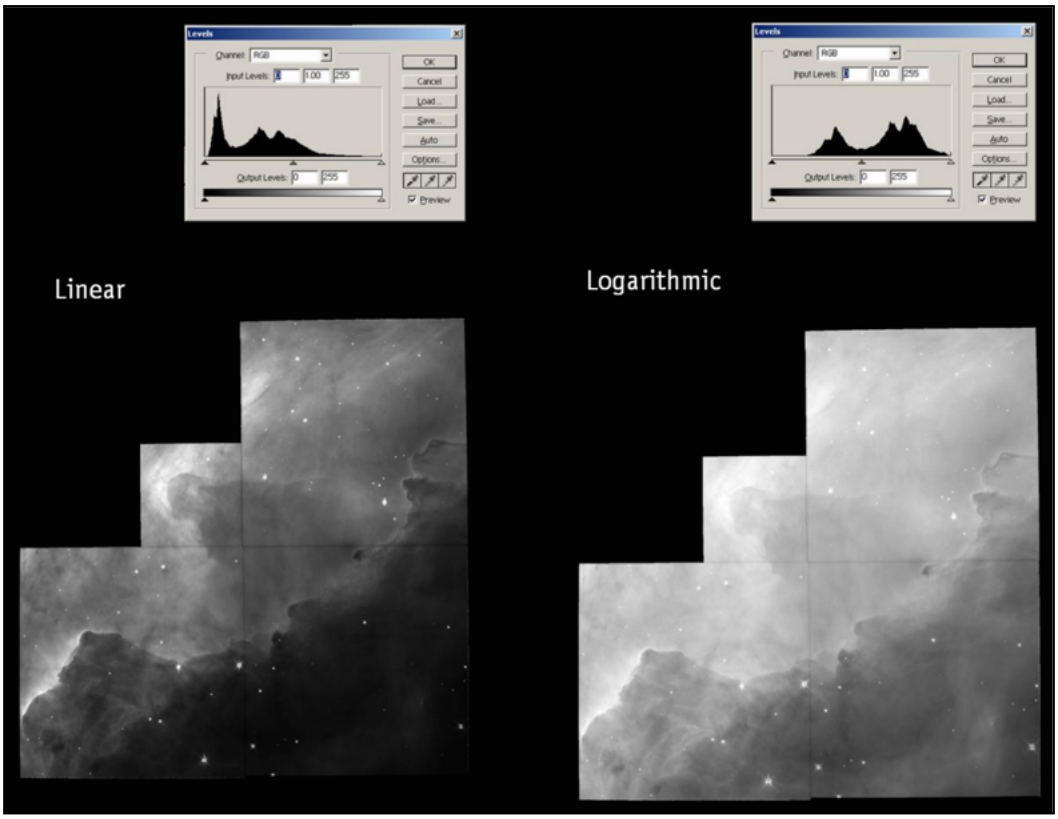


Figure 2 – *Linear (left) and logarithmic (right) pixel scaling values in the Eagle Nebula.*

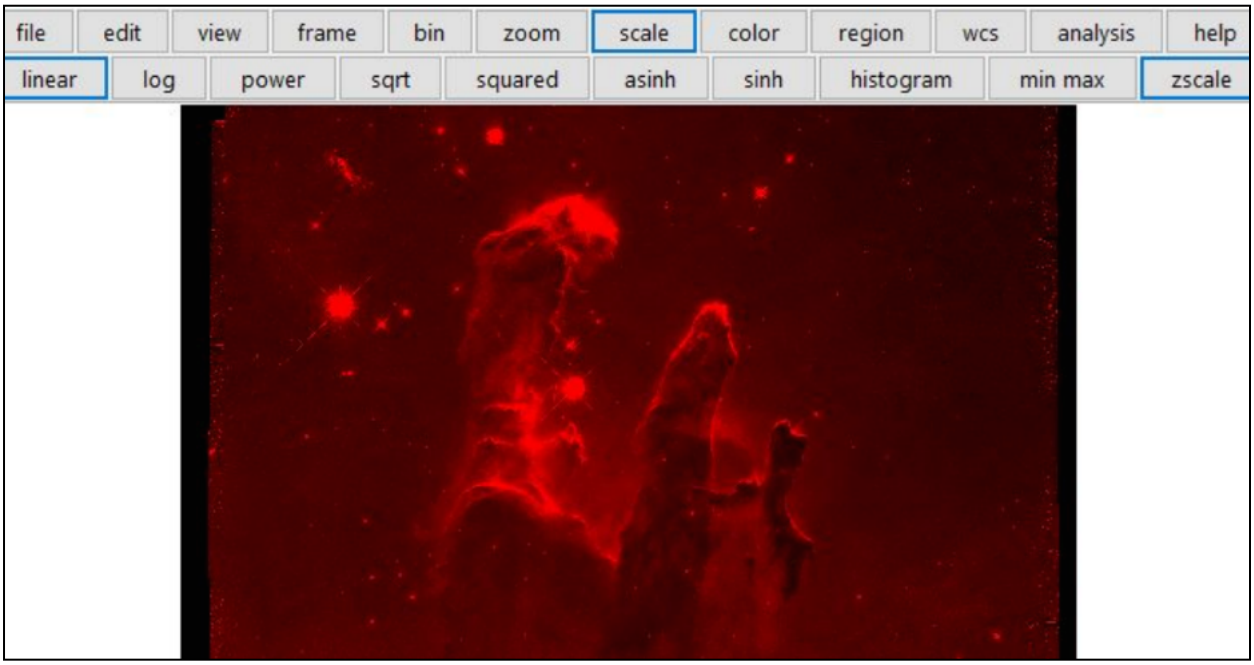


Figure 3 – *Example of what you see when loading only the red filter image of the Eagle Nebula.*

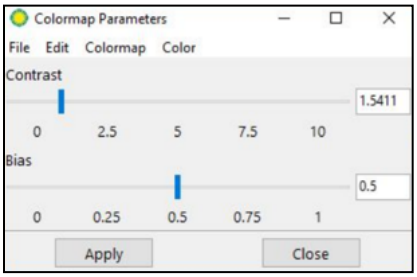
Next, in the pop-up window, click the Green toggle button. Repeat the **file→open** process to select your green image file. The red-and-green combination might look a little strange at this point — that's normal.

Finally, click Blue in the pop-up window and repeat the process with your last file.

This is how astronomers make the color space images you see in books or online. What you just did is the simple version — a lot more work can go into refining an image, similar to how a professional photographer edits a photo. Time permitting, we'll do some of that here too.

STEP 5: Refining your image. Two more tools help here: **scale parameters** and **colormap parameters**.

Go to **scale→scale parameters**. In the window that opens, the lower limit usually works best left at zero, but test it yourself. You can also adjust the upper limit (red circle, below) — just note the original number first so you can reset it if things look strange.



Next, fine-tune the colors. Go to **colors→colormap parameters**. This opens the sliding-bar window shown at right — again, note the original settings before changing anything.

Use the RGB window to switch between your three color layers. Each layer has its own scale and colormap settings, so adjust them independently: select a layer in the RGB window, then fine-tune its scale and colormap parameters as above.

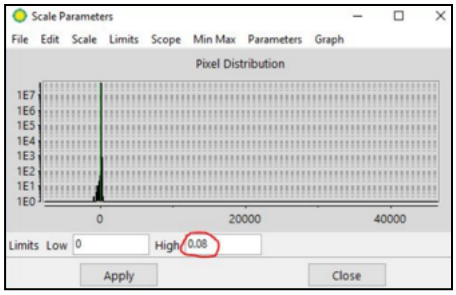


Figure 4 – *Example RGB image of the Eagle Nebula, also known as the Pillars of Creation, created by A. Gibson using SAOImageDS9.*

STEP 6: Pick your Object! Look through the astronomical objects on the next two pages and choose one to turn into your own cosmic photo.

[2] Question: What object did you pick?

[3] Question: Of the filters available for your object, which one gives the red image? The green? The blue? (*Hint: the number in each filter's name is its wavelength — see Figure 1. Longer wavelength = redder, but the filters aren't always listed in wavelength order.*)

Red Image =

Green Image =

Blue Image =

STEP 7: Repeat STEPS 4 and 5. Using your chosen object, repeat Steps 4 and 5 to create your own custom image. This will be printed on your tote bag, so make it your own!

STEP 8: Saving your image. When you're happy with it, take a **screenshot** to print on your tote bag. Press **command-shift-4** — this brings up a crosshair pointer — then drag from top-left to the bottom-right corner of the area you want, and release. **Rename the resulting desktop file with your name.**

Figure 4 shows an example (the Eagle Nebula). Even if you and a friend picked the same object, your images can look completely different — the colors and contrast are your aesthetic call.

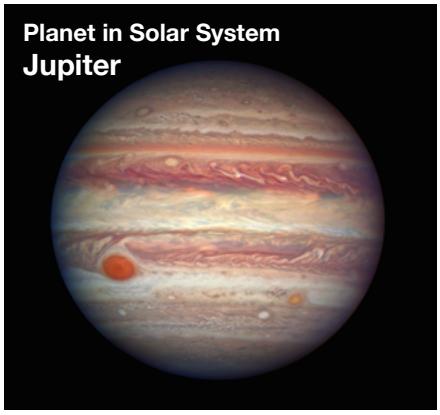
STEP 9: Fun Fact Search. Search for your astronomical object online — try adding "NASA" or "Hubble" to your search to find reliable sources (e.g., "Eagle Nebula NASA facts").

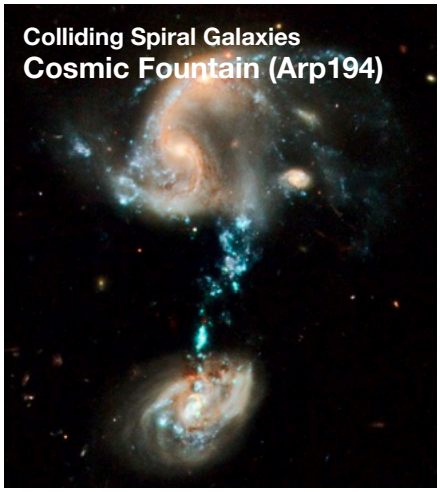
[4] Question: What's the most surprising or strange thing about your object?

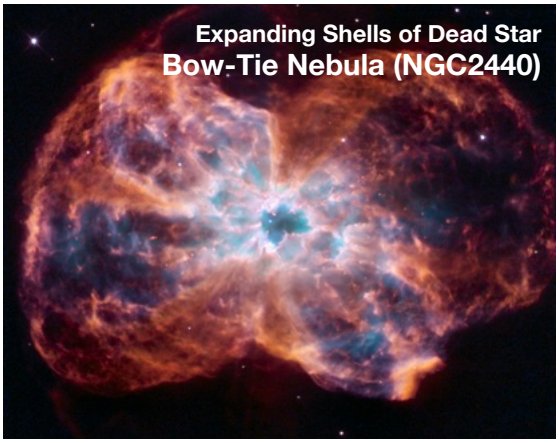
Look for things like: a record it holds (biggest, closest, oldest, weirdest shape), something happening inside it that couldn't happen on Earth, a comparison to something familiar (e.g., "this galaxy has 200 billion stars" or "this nebula is 7,000 light years across — that's 100 million times the width of our solar system"), or a mystery scientists haven't solved about it yet. *Bonus prize if one of them would surprise your friends!*

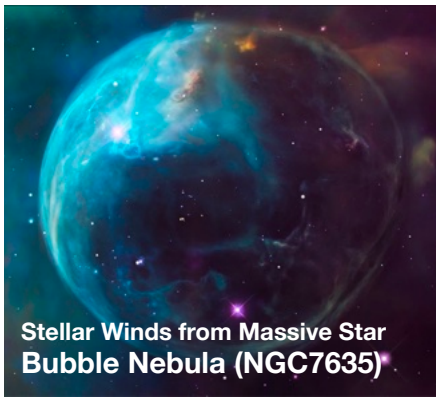
Fun Fact #1:

Fun Fact #2:





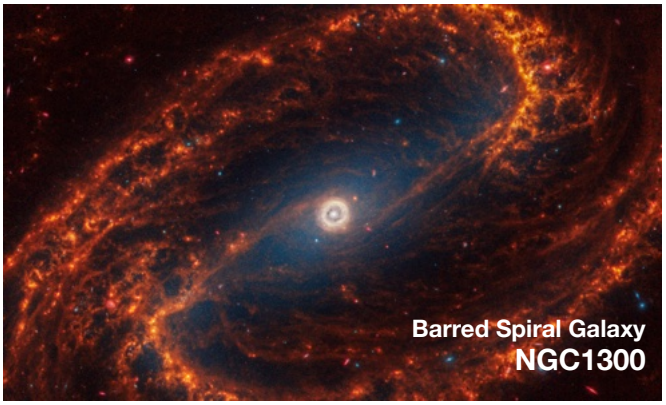




Pick your object!


Stellar Nursery
Carina Nebula


Cluster of Galaxies
SMACS0723


Barred Spiral Galaxy
NGC1300


Weakly Barred Spiral Galaxy
NGC1385


Expanding Shells of Dead Star
Southern Ring (NGC 3132)


Cluster of Galaxies
Abell2744


Interacting Galaxies
Stephan's Quintet