Name:

Cosmic Photoshoot to ImPress

DAY 2: Astronomy at Different Wavelengths

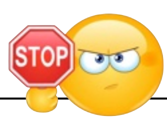
You have now created your own unique version of an iconic Space Telescope image.

> *Our example from Day 1 in Figure 4 shows the Pillars of Creation in visible light, imaged by the Hubble Space Telescope. The multi-colored gas clouds stand out against the dark dust. Radiation and winds from young stars inside the pillars are slowly eroding them. Hubble's sharp images let astronomers see this structure clearly and track how it changes over time.*
>
> *In 2022, the James Webb Space Telescope imaged the same object but in the infrared. Infrared light passes through the dust that blocks our view in visible light. Webb's image reveals hundreds of young stars hidden inside the pillars that Hubble couldn't see, plus red, wavy patterns where dust is being blown off the edges.*

Today, we will explore astronomy at different wavelengths, heat press your tote bag, and end with a showcase of your final products and the fun facts you learned.

I. What does the Infrared LOOK like?

STEP 0: Infrared Camera. We have two handheld thermal IR cameras for you to share. For your turn, take an image of one unique object in the room (get creative!). Later, we'll do a pop quiz using images like these — *whoever guesses the most correctly wins a prize!*



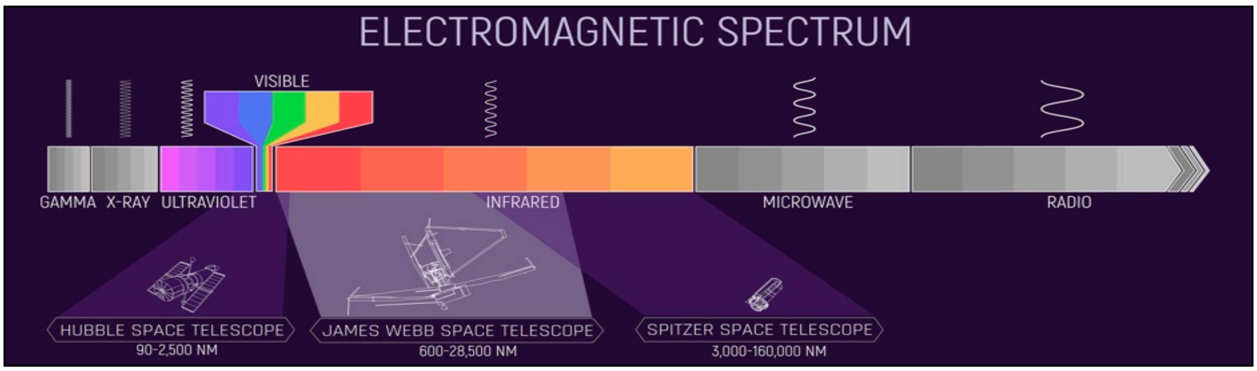
[1] Question: What does this object look like in infrared compared to how it looks to your eyes? *Write your answer in the box below.*

II. Comparing the Optical and Infrared Views.

STEP 1: Load the Images. Follow Steps 4/5 from Day 1 to make an RGB frame of the Pillars of Creation: (1) the optical narrow-band filter F502N for the blue filter, (2) F657N for green, and (3) F673N for red (all in **EXAMPLE/Optical/**). Adjust the settings until you have a color image you like. Open a second RGB image and load JWST/NIRCam F090W (blue), F200W (green), and F444W (red) (in **EXAMPLE/Near-Infrared/**).

STEP 2: Align the Images. Once you have two RGB frames loaded, align the frames so that you can directly compare them. Select the RGB frame with the zoom version you like and go to **Frame→Lock→Frame→WCS**, where WCS stands for World Coordinate System. You just told the software to match the images based on their world coordinate systems, where they should now be perfectly astrometrically aligned.

STEP 3: Blink, Blink, Blink. Flip between the two RGB frames using your tab key. Holding Shift-Tab blinks in the reverse direction. Take a few moments to look at the images and compare how they are similar and different.



[2] Question: Compare the different astronomical objects that can be seen in the optical and infrared views of the Pillars of Creation. What is similar? What is different? Are there any new objects that can be seen at infrared wavelengths?

[3] Question: The *Hubble Space Telescope* is only sensitive out to near-IR wavelengths of about 1.6µm, whereas NASA's new flagship mission the *James Webb Space Telescope* is sensitive into the mid-infrared (out to 28µm). How do you think the Pillars of Creation will look with the *James Webb Space Telescope* at the longest wavelengths of 7-28µm?

STEP 4: Explore the Mid-Infrared View. Now load a third frame with an RGB image using the mid-infrared images at 7-28μm (in **EXAMPLE/Mid-Infrared/**) using F770W, F1130W, and F1500W. Compare the footprints (field of view) of the optical (*Hubble Space Telescope*), near-infrared (*James Webb Space Telescope* NIRCam instrument), and mid-infrared (*James Webb Space Telescope* MIRI instrument) RGB images.

[4] Question: Why do you think the mid-infrared image covers a smaller area of sky?

III. Distances to Astronomical Objects.

STEP 5: Calculate Distance. Search Google for the distance to your object. Type in search bar: "*Distance to* __*(insert name of your object)*__ *in units of light years*". A light year is the distance light travels in one year (~5.9 trillion miles). It's a unit of distance, not time.

[5] Question: What is the distance to your object, in light years?

Now rewrite your distance using scientific notation (examples: 2,500,000 light years = 2.5×10^{6}, or 0.00058 light years = 5.8×10^{-4}). The exponent tells you the power of ten — 6 in the first example, -4 in the second. A negative exponent doesn't mean a negative number; it means division, giving you a small number between 0 and 1.

For comparison: Earth is 8.3 light-minutes from the Sun, or 1.6×10^{-5} light years (a power of ten of -5). Our nearest star beyond the Sun is about 4 light years away. And light that has traveled 1 million light years left its source before the last ice age on Earth!

[6] Question: Write your distance in scientific notation. What power of ten is it?

IV. Interactive Distance Ranking Activity.

Note (1) what your object is (planet, planetary nebula, galaxy, etc), and (2) the distance to your object. Sort among yourselves to rank the distance of your object from nearest to the Earth to the furthest.

V. Cosmic Photoshoot Showcase. Once all tote bags are done, please review your fun facts as you will teach the rest of us about your astronomical object.

Who Really Uses This? *Astronomers use all manners of data analysis tools and languages. The process you went through with SAOImageDS9 software was abbreviated (details were skipped), but the steps you took are the same steps that professionals take when analyzing their data. Many professional and amateur astronomers have spent endless hours in front of a computer analyzing the information encapsulated in the very same images you used today.*