Lecture Tutorial: The colors of astronomical images

In this lecture tutorial, we’re going to think about the colors in astronomical images, and what they represent. We’re going to begin by coloring a map of the Earth according to surface temperature.

1. You’re given a set of colored pencils: red, green, yellow, blue and purple. What color would you choose to represent the hottest parts of the Earth’s surface?

2. What color would you choose to represent the coolest parts of the Earth’s surface?

3. Using these colors and the intermediate colors, shade in the color bar below from hot to cold.

4. Using the full set of colors, shade in the provided map of the Earth. A map like this, where colors are chosen to represent something else (in this case, temperature) is often called a false color map.

5. Does this map of the Earth have the same colors as your eye would see, if you were looking at the Earth from a spacecraft? Why or why not?

6. Shade in the map below to represent what you think the Earth would look like from space. This is called a true color map, since it represents what the eye would see.
7. Two students (A) and (B) discover your two colored maps in a textbook, and have a debate about the images.

Student (A) says: *The first image of the Earth is misleading, because that’s not the way the Earth really looks to our eyes. It shouldn’t appear in this textbook.*

Student (B) says: *Although the first image of the Earth isn't what it looks like to our eyes, it represents true information about the Earth, and lets us learn about the Earth’s temperature. Therefore, it should be allowed in this textbook.*

Which student do you agree with and why?

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8. For astronomical objects (or anything that emits light), the hotter it is, the bluer the light it emits. Color in the map below so that the hottest parts are blue, and the coolest parts are red. This type of map doesn't really have a name, but we'll call it an *astronomical false color* map, where *astronomical* means that hotter parts are bluer in color.
9. Sometimes, only a single color is used in an image, and that color is shaded to represent brightness. Choose one color. Use this color, plus the black and white pencils, to shade the map of the Earth according to temperature. This type of map is often called a **monochrome intensity** map.

![Map of the Earth](image)

10. Below are four astronomical images with captions. Label each of these images as a **false color**, **true color**, **astronomical false color** or **monochrome intensity**, based on what you think is the most accurate description.

![Astronomical image](image)

Figure 1: This three color composite image of the irregular dwarf galaxy NGC 4449 is constructed from images in three bands: blue, green and red. The image is shaded in blue, green and red according to its strength in these bands. The red parts of the image represent star forming regions that appear cooler (redder) because the warmer (bluer) light is blocked by clouds of dust.
Figure 2: This image of the Andromeda galaxy was taken in an Hα filter, which represents very energetic emission from Hydrogen gas. The brightness of the image represents the intensity of the Hα Hydrogen emission.

Figure 3: This is an image of the ring nebula, M57. The color is chosen to represent the brightness of very high energy oxygen emission.

Figure 4: This image of the surface of Mars was taken by the Mars Exploration Rover Opportunity. The image was created from combined images in red, green and blue filters, which were scaled to approximate what would be seen by the human eye.